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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstract 4413.

2932 (AERE-R-5280) ANALYSIS OF PLUTONIUM SILICIDES AND PLUTONIUM SILICON CARBIDES. Milner, G. W. C.; Jones, I. G.; Phillips, G. (Atomic Energy Research Establishment, Harwell (England)). Sept. 1966. 16p. Dep. BIS $0.60. HMSO 3s.

Procedures are described for analysis of plutonium mono- and disilicides, and of plutonium silicon carbides containing from 3 to 14% silicon and 1 to 5.5% carbon. For determination of silicon, samples are ignited in air to remove carbon and then they are dissolved by an alkaline sodium peroxide sinter technique. Melts are partially dissolved in water, and solutions are completed with hydrochloric acid containing hydroxylamine hydrochloride. Silicon is separated from plutonium by cation exchange separation using Zeocarb 225 as the resin. Silicon in the column effluent is converted to its silicomolybdate complex before precipitation as quinoline silicomolybdate. The precipitate is filtered onto a sintered glass filter, dried at 150°C, and then weighed. The silicon content is determined from the weight of precipitate; the coefficient of variation of a determination is 1%. For determination of plutonium a separate sample is taken and dissolved in HNO_3 + HF before evaporation in fumes of sulfuric acid. The determination is completed by controlled-potential coulometry with a coefficient of variation of 0.1%. The carbon content is determined by direct combustion in oxygen at 1150°C for all samples except those containing silicon carbide. For these latter samples a $PbO-B_2O_3$ flux is necessary in conjunction with a temperature of 1330°C. The coefficient of variation for the carbon determination is about 0.3%. (auth)

2933 (DP-1039) CURIUM PROCESS DEVELOPMENT. III-3. ANALYTICAL CONTROL. Dukes, E. Kenneth (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Aug. 1966. Contract AT(07-2)-1. 16p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Established methods were modified and new methods were developed to provide analytical control for demonstration of the process to separate and purify curium from lanthanides and americium. Included are methods for determining americium, amine, californium, curium, lanthanum, lithium, and nitrate. (auth)

2934 (GAT-520) DETERMINATION OF URANIUM ALPHA ACTIVITY IN URINE. Shoaf, R. E.; Galloway, H. L.; Mullins, L. R. Jr. (Goodyear Atomic Corp., Piketon, Ohio). Sept. 1, 1966. Contract AT(33-2)-1. 6p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A procedure for the determination of uranium alpha activity in urine is presented. The method is readily adapted to a routine laboratory operation since a large number of samples can be handled by one analyst. The U was adsorbed from urine on a strongly basic anion-exchange resin in the nitrate form and then eluted with concentrated nitric acid. The organic material remaining in the eluate was destroyed by wet oxidation, and the alpha activity of the residue from this solution was measured with a proportional counter. The standard deviation of the alpha activities of spiked urine samples containing 1.0 microgram of U with a theoretical alpha activity of 148 dpm is ± 9.5 dpm. The standard deviations of routine control samples having alpha activities of 13.5 and 9.0 dpm per 100 ml urine is ± 4.1 and ± 3.0 dpm per 100 ml urine, respectively. (auth)

2935 (LA-3420) ANALYSIS OF UNDERGROUND WEAPON TEST EFFLUENT SAMPLES. Henderson, R. W. (Los Alamos Scientific Lab., N. Mex.). Sept. 1966. Contract W-7405-eng-36. 17p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

In the course of underground weapons testing, inadvertent releases of material to the atmosphere may occur. The composition of this material varies depending on the age of the fission products at the time of the release and the status of the operation. The methods and procedures used to derive the isotopic composition of the released material are described. (auth)

2936 (MSAR-66-221) DEVELOPMENT OF TECHNIQUES FOR MEASUREMENT OF IMPURITIES IN SODIUM. Quarterly Progress Report, July-September 1966. Andrews, R. C.; Barker, K. R.; Werner, R. C. (MSA Research Corp., Evans City, Pa.). Nov. 9, 1966. Contract AT(11-1)-765. 24p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Results are reported for studies on the development of equipment and methods for determination of impurities (including H, C, and O) in sodium. The methods discussed include: surface tension; solvent extraction; mass spectrometry; carburization; electrical potential concentration; electrical sensing; and continuous hydrogen monitoring. (P.C.H.)

2937 (UCRL-16806, pp 54-7) STUDY OF THE RING DEGRADATION OF TOLUENE-1-^{14}C. Lin, Tz-hong; Lemmon, Richard M. (California Univ., Berkeley. Lawrence Radiation Lab.).

Results are reported from a study of the chemical degradation of toluene-1-^{14}C. (C.H.)

2938 (IS-Trans-45) ANALYSIS OF METALLOIDS BY ACTIVATION WITH PHOTONS AND CHARGED PARTICLES. Englemann, Ch.; Cabane, G. Translated by G. W. Dickinson (Ames Lab., Iowa), from Paper Presented at International Conference on Modern Trends in Activation Analysis, College Station, Tex., Apr. 19-22, 1965. 28p. (CONF-650405-28). Dep. mn. JCL $2.60 fs, $1.04 mf.

It was found that some very sensitive analyses of boron and nitrogen can be made by proton irradiation. Contents of the order of 10^{-3} ppM are determinable with beams of 10μ amps in making a separation by combustion of ^{11}C. Between about 10 and 20 MeV, the specific activities of the two impurities in samples of thickness greater than the penetration depth are of the same order of magnitude. A precise analysis of one necessitates the determination of the other. Boron can be determined in the presence of large quantities of nitrogen (up to 100 times more) by irradiation at energies less than 5 MeV. The sensitivity is nevertheless reduced by a factor of 100 less than the sensitivity at 15 MeV. Nondestructive analysis of nitrogen and boron are possible in beryllium, silicon, and tantalum with sensitivities of 0.1 to 1 ppM with beams of 10μ amps. In the same matrices nondestructive analysis of oxygen as well as fluorine can be made with protons of energy greater than 10 MeV. Nondestructive determination of nitrogen in ultra pure berylium could be made with an excellent sensitivity. The necessity of using power from a cyclotron of variable energy is made evident in the work. It is shown that it is necessary to have irradiation powers of several energies to really discriminate between the various impurities that border at the same isotope activity. Activation analysis with protons allows determination of traces of nitrogen and boron in very-high-purity matrices. (auth)

2939 ELECTRON PYROLYSIS, A NEW METHOD OF ORGANIC MICROANALYSIS. Schildknecht, H. (Univ., Heidelberg). Angew. Chem. Int. Ed. Engl., 5: 751-9(Aug. 1966).

The process of electron pyrolysis was applied to amino acids, esters, lactones, amides, quinones, terpenes, N-S heterocycles, and some natural products. The organic compounds were specifically fragmented by incubation with titrated water of specific activity of 5 Ci/ml. The β-active fragments were detected in small quantities by chromatographic separation. Chemical identification of these fragments provided information about the original compounds. (B.L.M.)

2940 DETERMINATION OF TRACE SILVER IN HIGH-PURITY ZINC BY NEUTRON ACTIVATION. Mousty, F.; Fouarge, J.; Duyckaerts, G. (Univ., Liege). Anal. Chim. Acta, 36: 478-88(Dec. 1966). (In French).

Below the ppM level, the determination of silver in zinc by nondestructive γ spectrometry is no longer feasible due to the activation of the matrix element. The activated zinc is dissolved in nitric acid, sulfamic acid and silver carrier are added, and ^{110m}Ag (253 d) is obtained in a radiochemically pure state after two successive electrolyses on gold cathodes. After two days of irradiation in a thermal neutron flux of the order of 3×10^{13} n/cm^2 sec, 30 mg of silver can easily be evaluated with an error of 5%. Data obtained by integral γ counting or by γ spectrometry are compared. (auth)

2941 SECOND-ORDER INTERFERENCE IN THE NEUTRON ACTIVATION ANALYSIS OF ARSENIC IN A GERMANIUM MATRIX. De Neve, R.; De Soete, D.; Hoste, J. (Ghent Univ.). Anal. Chim. Acta, 36: 508-14(Dec. 1966).

The second-order interference ^{74}Ge(n,γ; β$^-$; n,γ)^{76}As that occurs in the activation analysis of arsenic in a germanium matrix, using thermal neutrons was determined experimentally. A practical formula was derived, for irradiation times longer than 2 hr, which showed that the interference, expressed as an apparent arsenic concentration, is proportional to the neutron flux. Experiments were performed for irradiation times of 10, 15 and 20 hr at a neutron flux of 10^{14} n/cm^2/sec, yielding apparent arsenic concentrations in the germanium matrix of respectively 223, 408, and 597 ppB. From these results a value of 0.48 ± 0.06 barn could be calculated for the activation cross section of ^{74}Ge for neutron capture. (auth)

2942 CONDUCTOMETRIC END-POINT DETECTION IN THE TITRATION OF FLUORIDE AND FLUOSILICIC ACID WITH THORIUM NITRATE. Israel, Yecheskel; Bernas, Bedrich; Yahalom, Aharon (Israel Mining Industries, Haifa). Anal. Chim. Acta, 36: 526-9(Dec. 1966).

The conductometric precipitation titrations of fluoride ion and fluosilicic acid with thorium nitrate were investigated in order to develop a reliable method suitable for the determination of fluoride ion in distillates of inorganic fluorides, as well as in the decomposition and distillation products of organofluorine compounds. The conductometric curves obtained were found to be suitable for end-point detection of both ionic species. The data obtained after the titration end-point were utilized to calculate the equivalent conductance of thorium nitrate from increments of conductance per increments of normality and the mean values obtained were 124.9 in aqueous solution and 62.6 in 50% (v/v) ethanol (at about 24°C). (P.C.H.)

2943 USE OF 8-HYDROXYQUINOLINE FOR THE SEPARATION OF ^{90}Y IN THE DETERMINATION OF ^{90}Sr IN BIOLOGICAL MATERIALS. Burton, J. D.; Love, R. M.; Mercer, E. R. (Agricultural Research Council Radiobiological Lab., Wantage, Eng.). Analyst, 91: 739-41(Nov. 1966).

Homogeneous precipitation of yttrium carrier as the 8-hydroxyquinolinate was used for the isolation and purification of ^{90}Y after the separation of the parent ^{90}Sr from biological materials. The technique was compared with the generally used method of separating by hydroxide and oxalate precipitations and estimating the recovery by weighing as the oxide. The two methods are of similar accuracy. Satisfactory decontamination from radioactive strontium was obtained by a single precipitation. The 8-hydroxyquinolinate can be weighed directly for measurement of chemical yield, and it has a more favorable gravimetric factor than yttrium oxide. (auth)

2944 RADIOISOTOPE X-RAY SPECTROMETRY. A REVIEW. Rhodes, J. R. (Atomic Energy Research Establishment, Wantage, Eng.). Analyst, 91: 683-99(Nov. 1966).

The present state of development of x-ray excitation with radioisotope sources and relevant methods of nondispersive energy selection and x-ray detection are reviewed. Reduction of interferences arising from absorption, enhancement, and particle-size effects is also discussed. The compactness, cheapness, and simplicity of the measuring head that result from the use of radioisotope excitation and nondispersive energy selection are being exploited by portable and "on-stream" analysers now commercially available. The basic techniques of excitation and energy selection were worked out but not yet evaluated for all possible applications. In many of the problems that were studied, alternative excitation and detection methods were used but not directly compared. Physical methods for overcoming absorption and enhancement effects were developed, mainly by analogy with conventional x-ray spectrometry. Suppression of particle-size effects in the analysis of heterogeneous materials remains a problem, especially as fusion techniques for removing the heterogeneity are virtually restricted to the laboratory. (auth)

2945 OXYHYDROGEN FLAME EXCITATION OF REFRACTORY ELEMENTS. Skogerboe, R. K.; Heybey, Ann T.; Morrison, G. H. (Cornell Univ., Ithaca, N. Y.). Anal. Chem., 38: 1821-4 (Dec. 1966).

Analytically useful atomic spectra of elements that form refractory oxides in flames were observed in oxyhydrogen flames (operated normally or reversed) by forced aspiration of organic solutions at above normal rates. Optimum flame conditions and emission sensitivity parameters were determined for the rare earths and many of the groups III, IV, and V elements. Among the advantages demonstrated are: sensitivities that are highly competitive with other flames, elimination of carbon deposition and burner clogging, and ability to analyze solutions of unusually high salt content without salt deposition. (auth)

2946 ACTIVATION ANALYSIS OF SILICON BY CONVENTION CARRIER SEPARATIONS AND BY COMPUTER REDUCTION OF GAMMA SPECTRA. Heinen, K. Gail; Larrabee, Graydon (Texas Instruments Inc., Dallas). Anal. Chem., 38: 1853-7(Dec. 1966).

The results of the analysis of silicon for various dopants in the concentration range from 0.55 ppB to 415 ppM by neutron activation analysis are reported. A rapid technique of computer reduction of complex gamma spectra was shown to yield results with comparable precision and in some cases better accuracy than the classical radiochemical separation techniques. The precision or reproducibility was shown to be ±5.3% of the amount present even in the low ppB region. Comparison of analytical and electrical results indicated an overall accuracy no worse than ±35% (compared with electrical results). The computer method of analysis yields results that average 6.1% higher than the radiochemical separation procedures. This agreement between the two radiochemical methods is considerably better than that expected based on other workers' statistical analysis of activation analysis procedures. Results are presented to show that arsenic is lost during silicon dissolution and previously published works on radiochemical determination of arsenic are probably in error. (auth)

2947 QUANTITATIVE GAS CHROMATOGRAPHIC ANALYSIS OF METALS, ALLOYS, AND METAL OXIDES, CARBIDES, SULFIDES, AND SALTS. Juvet, Richard S. Jr.; Fisher, Richard L. (Univ. of Illinois, Urbana). Anal. Chem., 38: 1860-5 (Dec. 1966).

A rapid, direct method for the quantitative analysis of alloys and certain metal oxides, carbides, sulfides, acetates, and nitrates by in situ reaction with F_2 in a specially designed reactor-injection system of a gas chromatograph followed by separation and analysis of the volatile metal fluorides on a chemically conditioned column is described. The reaction and elution properties of the elements: U, S, Se, Te, W, Mo, Re, Si, B, Os, V, Ir, and Pt in various chemical forms were evaluated. Quantitative determination of the first seven elements is reported. (auth)

2948 NUCLEAR MAGNETIC RESONANCE ANALYSIS OF ^{13}C ENRICHED METHANE. Eckstein, Ralph R.; Attalla, Albert (Monsanto Research Corp., Miamisburg, Ohio). Anal. Chem., 38: 1965-6(Dec. 1966).

The NMR spectrum of enriched methane was studied, and a ratio method involving hydrogen atoms bonded to both ^{12}C and ^{13}C was used to obtain ^{13}C content. ^{12}C does not exhibit nuclear magnetism. Although ^{13}C possesses this characteristic, its nucleus is not as sensitive to NMR absorption as the hydrogen atom and therefore gives a less intense absorption signal from equal numbers of nuclei. The proton NMR spectrum of naturally occurring methane gas consists of a large central absorption peak surrounded by two very small, approximately equally spaced, peaks on either side of the central peak. The large peak is due to absorption of rf energy by all protons bonded to ^{12}C atoms and the two smaller peaks are due to protons bonded to ^{13}C. The natural abundance of the two carbon isotopes is in the ratio of 98.9 to 1.1; relative intensities of the peaks follow in the order of 0.55 : 98.9 : 0.55. The determination of the relative abundance of the two carbon isotopes in ^{13}C-enriched methane gas was obtained from the ratio of the intensities of the two sets of proton absorption peaks. Experimental error in measuring of the ^{13}C abundance in enriched methane was ±0.2%. (D.H.M.)

2949 SAMPLE PREPARATION FOR LOW-LEVEL, ALPHA-PARTICLE SPECTROMETRY OF ^{226}Ra. Keisch,

Bernard; Levine, Arnold S. (Nuclear Science and Engineering Corp., Pittsburgh). Anal. Chem., 38: 1969-70(Dec. 1966).

Preparation of samples for low-level, alpha spectrometry of ^{226}Ra was developed in which ^{226}Ra was coprecipitated with a very small mass (0.1 to 0.2 mg) of $BaSO_4$ and filtered on a membrane filter. Good spectra and excellent ^{226}Ra recoveries were obtained and the descendant activities were allowed to grow in because of excellent radon retention. The alpha spectrum showed four main peaks: ^{226}Ra at 4.8 MeV; ^{222}Rn at 5.5 MeV; ^{218}Po at 6.0 MeV; and ^{214}Po at 7.7 MeV. The overall efficiency for ^{226}Ra measurement was constantly on the order of 85% with a typical background activity level of approximately 0.01 cpm for the four peaks combined. (D.H.M.)

2950 DETECTION OF DEUTERIUM OXIDE IN DIMETHYLSULFOXIDE-d_6 BY NUCLEAR MAGNETIC RESONANCE. Levenberg, Milton I.; Jeter, Delbert T. Jr. (Abbott Labs., North Chicago). Anal. Chem., 38: 1971-2(Dec. 1966).

A method for monitoring deuterium, as HDO and D_2O, in commercial dimethylsulfoxide-d_6 (DMSO-d_6) was found, and a technique for the removal of the deuterium was developed. Benzyl alcohol was used as a control sample. The technique resulted in accurate NMR integrals of labile protons and information useful in organic structural determination. (D.H.M.)

2951 SELECTIVE LIQUID-LIQUID EXTRACTION OF BERKELIUM(IV) WITH 2-THENOYLTRIFLUOROACETONE–XYLENE. APPLICATION TO THE PURIFICATION AND RADIOCHEMICAL DETERMINATION OF BERKELIUM. Moore, Fletcher L. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Anal. Chem., 38: 1872-6(Dec. 1966). (ORNL-P-2448).

A simple, rapid method for the radiochemical purification and determination of berkelium is described based on liquid–liquid extraction of berkelium(IV) with 0.5M 2-thenoyltrifluoroacetone–xylene. The high stability of the berkelium(IV) chelate provides marked selectivity from aqueous solutions of nitric, sulfuric, or hydrochloric acids. Sodium dichromate is an efficient oxidant for berkelium(III) tracer under the conditions required for optimum chelation and extraction of berkelium(IV). Nitric acid solution (10N) readily strips the berkelium from the organic phase. Excellent separation of berkelium is effected from many elements, including the alkalies, alkaline earths, trivalent lanthanides, ruthenium, zirconium, niobium, uranium, neptunium, plutonium, americium, curium, californium, iron, nickel, aluminum, and silver. Several useful analytical and process applications of this purification method are discussed. (auth)

2952 THE BARIUM DISTRIBUTION IN SEA WATER. Turekian, Karl K.; Johnson, David G. (Yale Univ., New Haven). Geochim. Cosmochim. Acta, 30: 1153-74(Nov. 1966).

More than 250 determinations of barium concentration in sea water were made using a neutron activation technique. In addition to observations on all the oceans, intensive studies in the Long Island Sound and east Pacific sector of the Antarctic Ocean were made. The results indicated that there is no universal correlation between the distribution of barium in oceanic profile and the concentration in deep-sea sediments. Correlation of barium with radium distribution in ocean water appeared to exist in the Caribbean but was doubtful in the east Pacific. The data were not sufficient to establish unequivocally the relationship of radium to barium. The major feature of the oceanic barium distribution is its narrow dispersion of concentrations. Barium is not removed in any significant manner in near-shore areas. The main deposits are in the deep-sea sediments, probably as barite, although all the various sources and paths of barium in the oceans are not yet clearly defined. (auth)

2953 ANALYTICAL CHEMISTRY. Headridge, J. B. (Univ. of Sheffield, Eng.); Pierce, T. B.; Anderson, D. M. W. Ann. Rep. Progr. Chem., Chem. Soc. London, 62: 511-46(1965).

Developments in analytical chemistry are reviewed including methods employing radiochemistry, activation analysis, and mass spectrometry. (570 references.) (TCO)

2954 INVESTIGATIONS IN NEUTRON ACTIVATION ANALYSIS. Brune, Dag (Aktiebolaget Atomenergi, Studsvik, Sweden). Svensk Kem. Tidskr., 78: 336-48(1966).

Numerous theoretical and practical aspects of selective activation by epithermal neutrons as applied to the determination of molybdenum in a steel alloy, whereby radiochemical separations were avoided, are discussed. In high-purity aluminum alloyed with Mg, the elements Cr, Cu, Fe, Ga, Hf, Mn, Sc, and Zn were determined. Chemical separations were obviated by proper choice of irradiation and decay times. The high resolution of the germanium semiconductor detector was demonstrated in determinations of nuclides with similar γ energies; the following pairs of nuclides were measured simultaneously: $^{134}Cs-^{137}Cs$, $^{42}K-^{24}Na$, $^{94}Nb-^{95}Nb$ and $^{95}Zr-^{95}Nb$. Reproducibility studies on the determination of 23 elements in biological specimens were also carried out. Descriptions are given of chemical separation techniques best suited for subsequent γ-spectrometric analysis. Levels of As, Au, Br, Cu, Fe, Mo, Se, and Zn in normal and uremic human whole blood were determined. A 10 times higher arsenic level in the uremic than normal blood was found. The distribution of Hg in human whole blood was studied by use of neutron irradiation at low temperature. The Szilard-Chalmers effect was employed for the separation of activities originating in neutron-irradiated biological material. Magnesium was determined in needle-biopsy specimens from living human muscle tissue using the Szilard-Chalmers separation technique. Two sources of error due to contamination from container material, inherent in the irradiation of a sample, were investigated. They arise from recoil effects in the thermal neutron capture processes and from the rinsing of the irradiated container surfaces. By a freezing technique, aqueous samples were irradiated in the solid phase, so that sources of error arising from contamination, vaporization, and adsorption were avoided. (BBB)

2955 DETERMINATION OF COLORED ORGANIC COMPOUNDS BY LIQUID SCINTILLATION COUNTER. Nagase, Yuso; Baba, Shigeo; Ido, Tachuo (Tokyo Pharmacy Univ.). Radioisotopes (Tokyo), 13: 412-14(Sept. 1964). (In Japanese).

An improved method of determination of colored organic compounds by liquid scintillation counting was studied by applying the electrolytic reduction principle and discriminator ratio method. Color quenching occurs due to the absorption of fluorescence from scintillator by the sample. The colored organic compounds are reduced to a colorless form and do not absorb the fluorescence from scintillator, thus the quenching is prevented. Quenching can also be corrected by measuring the relation between the degree of quenching and the change of discrimination ratio. In this experiment, 1 to 10 mg propiophenone(carbonyl-^{14}C)-2,4-dinitrophenylhydrazone was placed in 2 ml electrolyte solution, and at an electrode voltage of 25 to 30 V was reduced for 40 to 60 min. Hydrophilic scintillator (10 ml) was added and the radioactivity measured with TRI-CARB Model 314 EX liquid scintillation counter. Then the counts were corrected by discriminator ratio. Combination of the electrolytic reduction and discrimination method can shorten the measuring time and the quenching can be corrected to 5% variance of measured value. This method is suitable for routine measurement of biochemical experiments. During the electrolytic reduction, the reaction rate is hastened by applying high voltage. However, the high voltage produces side reactions; therefore, optimal voltage should be chosen for individual compounds. (BBB)

2956 FILTER PAPER DISK TECHNIQUES FOR ASSAYING RADIOACTIVE MACROMOLECULES. Bollum, F. J. (Oak Ridge National Lab., Tenn.). pp 296-300 of Procedures in Nucleic Acid Research. Cantoni, G. L.; Davies, David R. (eds.). New York, Harper and Row, 1966. (ORNL-P-1486).

A general method for working up radioactive polymer samples was developed and used for assaying the numerous enzyme fractions obtained during DNA polymerase purification and analysis. The method consists simply of numbering a series of Whatman No. 1 (or No. 3) cellulose disks (1-in. dia) and then applying the impure radioactive sample, such as an aliquot of a reaction mixture, to the properly numbered disk. The enzyme reaction is stopped by placing the filter paper disk in a large breaker of trichloracetic acid. A large number of such disks can be accumulated in a convenient washing vessel and all the samples can be accumulated and subsequently processed simultaneously through the several reagents necessary for extraction of extraneous material. After extraneous materials, such as ratioactive precursors, are removed from the radioactive product, the washing reagents that may interfere with the analysis of the radioactive product are removed by suitable solvents and residual water is removed by drying—either with solvents or air or oven drying. The radioactivity of the sample embedded within the fibers of the cellulose filter paper disk can now be determined without interference from radioactivity contamination by extraneous material and free from a large variety of quenching materials, such as salt and sucrose. Radioactivity of the sample can then be analyzed for the various types of isotopes that it may contain, either by scintillation techniques or by a straightforward Geiger counting procedure, depending on the isotope and detailed nature of the analysis required. The process is simple and the time required for washing is independent of the number of samples involved. (BBB)

2957 PHOTOMETRIC DETERMINATION OF LANTHANUM AND YTTRIUM IN ALUMINUM AND MAGNESIUM. Pinaeva, S. N.; Budanova, L. M. Zavodsk. Lab., 32: 1209-10(1966). (In Russian).

Photometric determination of La and Y using arsenazo III in a weakly acid medium at a pH of 3.0 to 4.0, followed by separation of Y by xylenol orange at a pH of 5 to 5.5, in the presence of a sulfosalicylic acid binding lanthanum into a stable complex, is de-

scribed. The determination takes 25 to 30 min with yttrium sensitivity limits of 0.07 μkg/ml and lanthanum of 0.02 μkg/ml. (R.V.J.)

2958 ON IMPROVED SENSITIVITY OF β REFLECTION ANALYSIS. Boyarshinov, L. M.; Senyavin, M. M. (Moscow Inst. of Steel and Alloys). Zavodsk. Lab., 32: 1220-3(1966). (In Russian).

A β-β reflection method with the reflected electron intensity as a function of atomic number close to Z^2 was used in order to improve the sensitivity of the analysis. The scheme of a device with annular aperture and six parallel connected Geiger counters around the ring is described. (R.V.J.)

2959 QUANTITATIVE ANALYSIS OF COMPLEX γ-RAY SPECTRA OF RADIOACTIVE METALS AND ALLOYS. Yanushkevich, V. A.; Ivanov, L. I. (Baikov Inst. of Metallurgy, USSR). Zavodsk. Lab., 31: 699-702(1965). (In Russian).

A system of linear equations was derived for describing complex γ spectra of mixtures of radioisotopes in terms of the spectra of standards obtained under similar conditions, and the most probable solution in a form suitable for practical use in activation analysis of metals and alloys is given. The application to a Zr–Nb alloy is described. (Analytical Abstr.)

2960 FACTORS AFFECTING THE SENSITIVITY AND SPECTRAL RESPONSE OF THERMOELECTRIC (RADIOMETRIC) DETECTORS. Stair, R.; Schneider, W. E.; Waters, W. R.; Jackson, J. K. (National Bureau of Standards, Washington, D. C.). Appl. Opt., 4: 703-10(1965).

An investigation was made of the variations in sensitivity of thermopiles with wavelength. The variations in spectral sensitivity were a function of the type of instrumentation used (dc, ac, or ac synchronous rectifier), and there were significant variations in sensitivity for different areas of the surface of a thermopile. (Analytical Abstr.)

2961 RADIOACTIVE METHOD FOR THE LOCALISATION AND ESTIMATION OF SITOSTEROL ON PAPER CHROMATOGRAMS. Abdel-Wahab, M. F.; Selim, N. L. (MERR Centre for Arab Countries, Cairo). Z. Anal. Chem., 211: 195-201(1965).

The developed chromatogram is treated with KIO_3 and KI containing ^{131}I, and the presence and amount of the iodinated sitosterols are determined by scanning the chromatogram with a commercial scanner, or by autoradiography. The separation is carried out on paper impregnated with liquid paraffin by development with liquid paraffin–acetic acid–water (1:19:1, w/v/v). (Analytical Abstr.)

2962 MICRO-DETERMINATION OF IODIDE BY ISOTOPIC-DILUTION ANALYSIS. Beronius, P. (Royal Inst. of Tech., Stockholm). J. Electroanal. Chem., 9: 473(1965).

A solution containing w_1 μg of I^- labeled with ^{131}I is placed in an electrolytic cell, and its specific activity is determined by depositing ≈1% of its iodine content on a silver anode and then measuring the activity of the deposit. The test solution (containing w_2 μg of I^-) is then placed in the cell, and the change in activity is established by a second deposition on a fresh anode. The value of w_2 is then calculated from $w_2 = w_1(A_1/A_2 - 1)$, where A_1 and A_2 are the activities per unit amount of electricity passed for the first and second anode, respectively. The technique was used for determining ≈20 μg of I^-. (Analytical Abstr.)

2963 DETERMINATION OF TRACES OF CARBON IN METALS BY NON-AQUEOUS TITRATION. Boyle, W. G. Jr.; Stephens, F. B.; Sunderland, W. (Univ. of California, Livermore). Anal. Chem., 37: 933-5(1965).

The procedure consists in combustion of the sample (0.1 to 0.6 g) in O in an induction furnace, followed by continuous titration of the resulting CO_2 (after its absorption in dry acetone in a cell) with 0.005N or 0.02N NaOH in pyridine–methanol; thymol blue was used as internal indicator. A drift-rate correction must be made after each run to compensate for the gradual drift of the end-point caused mainly by the presence of H_2O and excess of methanol in the solvents. The sensitivity is ≃ ±1 μg of C when 0.005N titrant is used; the 0.02N titrant is used when the total C content exceeds 200 μg and the sensitivity is then ≃ ± 4 μg. The rate of flow of O (≃1.2 liters per min) is higher than that used by White, thus extending the range of samples for analysis, viz, stainless steel, uranium, beryllium, boron, and various alloys and ceramics. (Analytical Abstr.)

2964 DETERMINATION OF ^{210}Pb BY DITHIZONE EXTRACTION AS ^{210}Bi. Ashizawa, Takashi; Nagasawa, Kikuo; Haruyama, Kanji (Japan Atomic Fuel Co-op., Tokyo). Bunseki Kagaku, 13: 1011-16(1964). (In Japanese).

Optimum conditions were established for the extraction of Bi into dithizone in CCl_4, and a method was devised for determining ^{210}Pb in uranium ore. The sample, plus carrier Pb, is dissolved in aqua regia, then Pb is precipitated as sulfate. The precipitate is converted into carbonate, and this is dissolved in HNO_3. The solution is made 0.1M in acetate and its pH is adjusted to 1.5 with NH_3; it is then shaken with dithizone in CCl_4 (2 × 10 ml), and the aqueous layer is set aside for 3 days for the growth of ^{210}Bi, which is similarly extracted and determined by β counting. (Analytical Abstr.)

2965 ANALYSIS OF HEAVY WATER IN CONCENTRATIONS NEAR TO [THAT IN] NATURAL WATER. III. Otero de la Gandara, J. L.; Gispert, M.; Rojas, J. L. An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 61: 1155-62(1965). (In Spanish).

The two-image float method previously used at 25°C was modified to operate at 10 and at 6°C, and the accuracy was improved. (Analytical Abstr.)

2966 RADIOMETRIC DETERMINATION OF SILVER. Smit, J. van R. (CSIR, Pretoria). Analyst, 90: 366-7(1965).

In work by Pierce on equilibration of a solution of the oxodithizonate of radioactive Ag in an organic solvent with an aqueous solution containing an unknown amount of inactive Ag, it was known that if conditions are such that the amount of Ag passing from the organic to the inorganic phase during equilibration is negligibly small, and if S_i (moles of Ag originally in the aq. phase) is much less than S_a (moles originally in the organic phase), the counting rate at equilibrium should be proportional to the specific activity of the radioactive Ag taken. Pierce confirmed this by an experimental calibration graph for amounts of Ag from 0 to 12 μg, which was rectilinear from 0 to 1 μg of Ag, although subsequently curved. It is now shown that by plotting the results in a different form, expressing the amounts of Ag as mass units instead of as equivalents and re-arranging the original equation without the assumption that S_i is much less than S_a, and with the terms expressed as their reciprocals, a wholly rectilinear graph is obtained. (Analytical Abstr.)

2967 ACTIVATION ANALYSIS OF TRACE IMPURITIES IN ALUMINIUM. Ko, Chiung-hui; Cheng, Hua-sheng (National Tsing Hua Univ., Hsinchu, Formosa). J. Chin. Chem. Soc. (Taiwan), 12: No. 1-2, 39-50(1965).

Experimental details are given for the determination of Mn, Ni, Co, Cu, and Fe by activation analysis, and of Na and K by flame photometry. (Analytical Abstr.).

2968 WET-CHEMISTRY DETERMINATION OF CERIUM IN CAST IRON, UNALLOYED AND ALLOYED STEEL. Kraft, G.; Dosch, H. (Metallgesellschaft AG, Frankfurt am Main). Z. Anal. Chem., 222: 319-28(1966). (In German).

Ce contents of 0.0005% and above in cast iron and steels of different compositions were determined with a standard deviation of ±3% rel. (for Ce contents of 0.005%). Cerium was precipitated twice as oxalate, under special conditions, in the presence of thorium as collecting agent and titrated with a 0.0005N Fe^{II}-solution using voltametric indication. (auth)

2969 TRACE ANALYSIS UTILIZING PAPER CHROMATOGRAPHY AND RADIOACTIVE PRECIPITANTS. Welford, George A.; Chiotis, Elias L.; Morse, Robert S. (Health and Safety Lab., Atomic Energy Commission, New York). J. Chromatog., 25: 144-52(Nov. 1966).

A technique, combining paper chromatography as the separation process with radiometric precipitation for quantitative determination, is presented for the determination of trace elements. Procedures are described that are capable of determining submicrogram quantities of elements. The accuracy and precision of the technique were evaluated for the sulfates of Sr, Ba, Ca, and Pb; the phosphates of Zr, Hf, Th, Be, Al, Mn, Ba, Sr, and Ca; and the sulfides of Ni, Mn, Co, Pb, Zn, and Fe. (D.H.M.)

2970 INTEGRAL METHOD FOR THE DETERMINATION OF RADIOGENIC ARGON IN MINERALS BY USING A MASS SPECTROMETER. Chedzhemov, G. Kh. Mineral. Sb., Lvov. Gos. Univ., 18: 157-64(1964). (In Russian).

The method is based on the determination of the "loss" of radiogenic Ar by its effect on the amount of ions recorded on a mass spectrometer MI-1305 (with slits of 0.5 mm at the ion source and 2 mm at the receiver). The method can be used to date "young" minerals ($<10^6$ years); for older minerals small samples are taken. The procedure can also be used to determine other elements. (Analytical Abstr.)

2971 ANALYSIS OF URANIUM CONCENTRATES AT THE NATIONAL BUREAU OF STANDARDS. Richmond, M. S. Nat. Bur. Stand. (U.S.), Misc. Pub., No. 260-8, 96p.(1965).

Samples from more than 50 producers were examined over a 15-year period. All samples were analyzed by a single method involving dissolution in acids, removal of interfering substances by precipitation as sulfides, extraction with $CHCl_3$-cupferron, reduction in a Jones reductor, and titration with $K_2Cr_2O_7$ solutions.

A procedure applicable to all types of material is described in detail. The primary problem was the establishment of a reliable sampling base-line; several problems arising from the study are presented. (Analytical Abstr.)

2972 ISOTOPE ANALYSIS OF BCl_3 ENRICHED WITH ^{10}B. Demidenkova, I. V.; Chizhik, T. N. Tr. Gos. Inst. Prikl. Khim., No. 52, 158-60(1964). (In Russian).

An infrared spectrophotometric method is described for determination of the isotopic composition of BCl_3. The measurements were carried out in glass at pressures of 10 to 12 torr for $C(^{10}BCl_3)$, 15 to 40% using a frequency ν_3 of 954 cm^{-1}. A frequency of 994 cm^{-1} was used for $^{11}BCl_3$. The calibration line was plotted as $D(^{11}BCl_3)/D(^{10}BCl_3)$ vs $C(^{11}BCl_3)/C(^{10}BCl_3)$ where D = optical density and C = concentration. The error of the method is <5%. (TTS)

2973 SPECTROSCOPIC DETERMINATION OF $^{12}C-^{14}C$ CARBON ISOTOPES IN RADIOACTIVE COMPOUNDS. L'vov, B. V.; Mosichev, V. I. Tr. Gos. Inst. Prikl. Khim., No. 52, 64-76(1964). (In Russian).

A method is described for the spectrophotometric determination of carbon isotopes in $^{12}C-^{14}C$ compounds. It is based on photoelectric measurements of the 1,0 band edge of the Angstrom system for the transition $B^1\Sigma \rightarrow A^1\pi$ in the $^{14}C-^{16}O-^{12}C-^{16}O$ spectrum. A Mo-glass tube filled with N_2 free CO_2 was used for the measurements, and the spectrum was excited with a high-frequency discharge. The calibration curve was linear for a concentration range of ^{14}C of 0 to 50% with an absolute standard deviation of 0.6 to 0.8%. (TTS)

2974 SPECTRAL DETERMINATION OF THE ISOTOPIC COMPOSITION OF Hg. L'vov, B. V.; Mosichev, V. I.; Plyushch, G. V. Tr. Gos. Inst. Prikl Khim., No. 52, 141-52(1965). (In Russian).

A method is reported for the determination of ^{199}Hg in mixtures with ^{198}Hg by absorption spectrum measurements. Samples of HgI mixed with Ar were prepared in quartz tubes and excited by a high-frequency discharge from a high-frequency generator of 45W at 145 Mc. A Fabry-Perot interferometer crossed with a mirror monochromator was used to analyze the hyperfine structure of the Hg lines 4046.58, 4077.83, and 4358.33 Å. The apparatus is discussed, and the diaphragm radius is computed from an empirical formula. (B.L.M.)

2975 DETERMINATION OF URANIUM AND THORIUM METALS IN FUEL ELEMENT CORE MATERIALS BY SELECTIVE DECOMPOSITION OF THEIR HYDRIDES. Hibbits, James O.; Schaefer, E. Allen (General Electric Co., Cincinnati). Contract AT(40-1)-2847. Anal. Chem., 38: 1687-91(Nov. 1966).

Uranium and/or thorium metal can be determined in sintered UO_2, ThO_2, UO_2-ThO_2, or $W-UO_2$ specimens subject to certain qualifications. The method of determination involves formation of the hydrides UH_3 and Th_4H_{15}, and their selective decomposition. At 325°C, UH_3 decomposes to U and H_2 and Th_4H_{15} decomposes to ThH_2 and H_2. At 600°C, ThH_2 decomposes to Th and H_2. The hydrogen released by decomposition is determined by gas chromatography. Accuracy of the determination is limited by the location of the metallic phases(s) present. In general, metal located along a grain boundary will react with hydrogen and subsequently be determined, whereas metal located within a grain will probably not hydride and, thus, will escape subsequent detection. The method is not applicable to $Mo-UO_2$ specimens because of the solubility of U metal in Mo. A high-Mo-low-U alloy does not hydride to any appreciable extent under the conditions described. (auth)

2976 DETERMINATION OF REFRACTORY OXIDE ELEMENTS BY ATOMIC ABSORPTION SPECTROMETRY WITH THE PLASMA JET. Friend, Karl E.; Diefenderfer, A. James (Lehigh Univ., Bethlehem, Pa.). Anal. Chem., 38: 1763-4(Nov. 1966).

The use of a plasma jet to prevent the formation of refractory oxides in atomic absorption spectrometry has been applied to the determination of Al and V. The sensitivity for Al in 95% ethanol was found to be 2.7 μg of Al/ml for 1% absorption using the 3092.7 Å line; and for V in methanol was found to be 18 μg of V/ml using the 3185.4 Å line. The relative standard deviation was ~6%. Work is in progress to extend the procedure to the determination of La. (B.L.M.)

2977 GAMMA-GAMMA COINCIDENCE COUNTING APPLIED TO CHLORINE ANALYSIS BY NEUTRON ACTIVATION. Bramlitt, Edward T. (Atomics International, Canoga Park, Calif.). Contract AT(38-1)-386. Anal. Chem., 38: 1669-74 (Nov. 1966).

A routine neutron-activation method for determining trace quantities of chlorine in organics was developed, which eliminates the effect of interfering impurity activities. The method has significantly extended the experimental sensitivity for chlorine detection and at the same time has improved the precision and accuracy of the determination. Chlorine can be determined down to a concentration of about 10 ppB ± 50% relative standard deviation. In the 0.4 to 2 ppM chlorine concentration range a relative standard deviation of about 7% is attainable. (auth)

2978 NEUTRON ACTIVATION ANALYSIS. SIMPLEX METHOD OF LINEAR PROGRAMMING. Kerrigan, Felix J. (Veterans Administration Hospital, Omaha). Anal. Chem., 38: 1677-80(Nov. 1966).

Linear programming was applied to the problems of gamma spectrum analysis to determine the abundance of various elements in serum and tissue. The method is both quantitative and qualitative in its application. A detailed discussion of the mathematical principles is presented, and graphic illustrations are included to give indication of the accuracy of the method. (B.L.M.)

2979 DETERMINATION OF POTASSIUM, RUBIDIUM, AND BARIUM IN THEIR TUNGSTEN BRONZES BY NEUTRON AND HIGH ENERGY PHOTON ACTIVATION. Wechter, Margaret A.; Voigt, Adolf F. (Ames Lab., Iowa). Anal. Chem., 38: 1681-3 (Nov. 1966).

The method of activation analysis was applied to the determination of K, Rb, and Ba in their "tungsten bronzes," $M_xWO_3 (0 < x < 1)$ using three different irradiation techniques. In the case of K, synchrotron bremsstrahlung were used to produce the reactions $^{39}K(\gamma,n)^{38}K$ and $^{186}W(\gamma,p)^{185}Ta$, and the ratio of ^{38}K to ^{185}Ta activities was compared to that found in samples of known composition. Rubidium was determined by thermal neutron activation; ^{88}Rb activity was compared to that induced in standard samples. Barium was determined by activation with 14-MeV neutrons by means of the reactions $^{137}Ba(n,n')$ and $^{138}Ba(n,2n)$ to produce ^{137m}Ba compared with standard samples irradiated simultaneously. In all cases it was possible to avoid interfering activities so that radiochemical separations were not necessary. The accuracy of the methods was established by analyzing synthetic tungsten bronzes prepared with a known metal-to-tungsten ratio. (auth)

2980 ISOLATION OF MICROAMOUNTS OF URANIUM USING THE ANIONITE WOFATIT SBW. Scheel, H.; Feddersen, B. (Staatliche Zentrale fuer Strahlenschutz der DDR, Berlin). Kernenergie, 9: 256-9(Aug. 1966). (In German).

Uranium was isolated from 0.05M H_2SO_4 using the anionite Wofatit SBW for its colorimetric determination by arsenazo. After sorption of uranium the ion-exchange bed was treated with a solution of 90 ml of 0.05M H_2SO_4 and 10 ml of a 6% sulfurous acid, then with 50 ml of 1M $(NH_4)_2SO_4$ in 0.025M H_2SO_4. The uranium was eluted with 0.5M $HClO_4$. Permissible amounts are given for 22 ions. The method outlined is applicable to radiation protection measurements. (auth)

2981 PHOTOMETRIC DETERMINATION OF CERIUM AND SOME OTHER RARE EARTH METALS BY MEANS OF ARSENAZO III. Budanova, L. M.; Pinaeva, S. N. Zh. Anal. Khim., 20: 320-4(1965). (In Russian).

A method was devised for determining Ce, La, Nd, or Y in alloys based on Al and Mg. Interference from Al, Mg, Cu, and Fe can be avoided by adding sulfosalicylic acid and thiourea, and benzenearsonic acid is added to prevent interference from Zr. One gram of alloy (containing at least 0.1% of rare earth metals) is dissolved in 40 ml of HCl (1 : 1), with heating, and the solution diluted to 250 ml with H_2O. To 1 ml of this solution 30 to 40 ml of H_2O and 10 ml of 5% thiourea are added. After 10 min 10 ml of 20% sulfosalicylic acid solution, 5 ml of 5% benzenearsonic acid, 5 to 8 drops of 0.1% ethanolic pentamethoxy red, and dropwise, 50% Na acetate are added until the pink color is formed. Then 5 ml of 0.04% aqueous arsenazo III are added, the solution diluted with H_2O to 100 ml, mixed, and the extinction at 655 mμ measured against a blank solution containing no rare earth metals. A determination takes ≈40 min, and the relative error is ± ±5%. The sensitivity is 0.02 μg of rare earth metals per ml of final solution. By suitable modification of the method, individual determinations of Ce, La, Nd or Y can be carried out. (Analytical Abstr.)

2982 NON-DESTRUCTIVE ANALYSIS OF ANCIENT SILVER COINS. Das, H. A.; Zonderhuis, J. (Reactor Centrum Nederland, Petten, Netherlands). Rec. Trav. Chim., 85: 837-41(Aug. 1966).

The methods of specific gravity, thermal neutron activation, and x-ray fluorescence were applied to the nondestructive analysis of 34 silver coins from Sicyon. According to the dimensions and weights, the coins could be divided into six groups. The results of the Ag, Cu, Pb, and Au analyses are given in tabular form for the six groups. (B.L.M.)

2983 THE NON-CHARACTERISTIC, SOFT X-RADIATION FORMED IN THE INTERACTION OF GAMMA-RADIATION AND

MATTER. Vertes, Attila (Eotvos Lorand Scientific Univ., Budapest). Magyar Kem. Foly., 72: 344-6(Aug. 1966). (In Hungarian).

The intensity vs. absorbent layer thickness relationship was interpreted in terms of the theory according to which the non-characteristic, soft x ray induced by γ rays is a braking x ray caused by the braking of the electrodes evolved in the photoeffect. The calculations based on this theory gave results that correlated well with experimentally determined data. This phenomenon may be employed for analytical purposes. (JPRS)

2984 DETERMINATION OF BORON-ISOTOPE COMPOSITION ON THE BASIS OF THE MASS SPECTRUM OF METHYL BORATE. Opauszky, Istvan; Matus, Lajos; Kiss, Istvan (Central Research Inst. for Physics, Budapest). Magyar Kem. Foly., 72: 346-50(Aug. 1966). (In Hungarian).

The mass spectrum of trimethyl borate was investigated in order to develop a method by which the isotopic ratio $^{11}B/^{10}B$ could be directly determined from the mass spectrum of the compound. It was found that there are some ions to be compared with respect to intensity to perform the isotopic analysis. The suggested method has the advantage over previously known techniques in that it allows evaluation of the isotopic composition without the need of using pure isotope standards. (JPRS)

2985 LAZY SUSAN DEVICE FOR RADIOACTIVE SAMPLE MOUNTING. Schulz, W. W. (Battelle-Northwest, Richland, Wash.); Neil, L. C.; Poole, H. L. Chem.-Analyst, 55: 116-17 (Oct. 1966).

A device for mounting and successively rotating for alpha counting eight planchets consists of a stainless steel disc mounted on a steel rod that rests in a hard-pressed, heavy board base. The complete assembly is $4\frac{1}{2}$ in. in dia and 2 in. high. The positions for the planchets are milled $\frac{1}{32}$ in. deep and numbered. A slot is milled to the edge of each of the numbered positions to permit manipulation of the planchets with tweezers. (B.L.M.)

2986 PHOTOMETRIC DETERMINATION OF THE RARE EARTHS WITH MUREXIDE. Sangal, Satendra P. (Univ. of Allahabad, India). Chem.-Analyst, 55: 104-6(Oct. 1966).

A method is described for determination of rare earths by measurement of the absorbance at 480 mμ of their complex with murexide. The optimum pH for the determination, the concentration for effective determination, and the sensitivity for various rare earths are presented in tabular form. (B.L.M.)

2987 ANALYSIS WITH THE AID OF RADIOACTIVE REAGENTS. Lerch, P. (Institut de Radiophysique Appliquee, Lausanne, Switzerland). Microtecnic, 20: 414-15(Aug. 1966).

The definition and principle of the technique of using a radioactive reagent in a chemical reaction that results in a change in phase of the reactants are outlined. This change of phase can be release of gas, solubilization of a fine suspension by complexation, or precipitation. As an alternate to adding the radioactive reagent in excess and measuring the amount present in a product or in measuring the excess, the radioactive reagent can be added by means of a titration method. This method of titration is applicable to a titration reaction that forms a precipitate as well as to one in which either the solvent or a reaction product must be removed by solvent extraction. All the experimental techniques as well as a titration arrangement are described in detail. (B.L.M.)

2988 SOME APPLICATIONS OF ATOMIC ABSORPTION IN THE ANALYSIS OF NUCLEAR MATERIALS. Hainski, Z. (Euratom-CCR, Ispra, Italy); Rossi, G.; Omenetto, N. Met. Ital., 58: 339-46(Aug. 1966). (In Italian).

A simple fast analytical procedure is described for the determination of neutron-absorbing trace elements of the Cd and Co type in SAP and uranium. The method is based on the atomic absorption technique. The extraction method using dithizone and the long-chain tertiary amine TNOA is discussed. The sensitivity is such that a very small quantity (0.5 g) of initial sample is necessary. It is shown how the quasi-absolute lack of interference permits direct analysis of Zn in SAP. The apparatus consists of the single-ray Jarrell–Ash model with continuous amplification of the signal and the hollow cathode tube used for the elements mentioned is of the sealed type with non-interchangeable cathode. The atomization source is constituted by an air–hydrogen flame. Various types of interchangeable hollow cathode tubes, water-cooled and operating in an argon flux, are illustrated. Their operational characteristics are given. The method for the preparation and conditioning of the cathodes is described. A calibration curve for Sr up to a limit of 0.1 ppM was obtained for one of the cathodes. The sensitivity limits for the other elements Zn, Cd, and Co are 0.006, 0.01, and 0.1 ppM, respectively. (tr-auth)

2989 SEPARATION AND DETERMINATION OF RADIOACTIVE CESIUM IN MILK. Hahn, Richard B.; Johnson, Jack L.; McKay, J. Brian (Wayne State Univ., Detroit). Talanta, 13: 1613-18(Dec. 1966).

A method is given for the separation and determination of radiocesium in fluid milk. Cesium was separated from organic material and interfering ions by passage of the milk sample through a cation-exchanger in the lithium form. It was eluted from this column with 6M hydrochloric acid. Two methods are given for the recovery of radiocesium from the eluate. It may be precipitated with silicotungstic acid and then converted into cesium perchlorate for counting or weighing. Alternatively, the eluate is passed through a small column of ammonium phosphomolybdate, which quantitatively sorbs the radiocesium, the activity of which is determined by putting the column in a well-type scintillation counter and measuring the activity. Approximately 90% of the radiocesium was recovered. (auth)

2990 AUTOMATIC SCANNING OF CHROMATOGRAMS BY MULTI-SCALING WITH A GAMMA-RAY SPECTROMETER. Muzzarelli, R. A. A. (Sherbrooke Univ., Can.). Talanta, 13: 1689-93(Dec. 1966).

The location of gamma-emitting isotopes on chromatographic thin layers was achieved, together with qualitative and quantitative analysis, by using a gamma spectrometer. This technique was applied to the determination of the chromatographic behavior of nanogram amounts of ^{51}Cr, ^{54}Mn, ^{59}Fe, ^{60}Co, ^{65}Zn, and ^{109}Cd thiocyanate complexes on silica gel. Separations were made of Co, Zn, and Cd from Cr, Mn, and Fe. (auth)

2991 INDIVIDUAL TRACERS FOR ISOTOPE DILUTION ANALYSIS OF RARE GASES. Reynolds, J. H.; Spira, R. (Univ. of California, Berkeley). Nucl. Instrum. Methods, 42: 225-8 (July 1966).

A method of preparation of individual tracers in large lots for isotope dilution analysis of rare gas is described. The gas content is about 10^{-5} cm^3 STP. Absolute calibration procedures, described, can fix the content of the ampoules within 1.7%. Uniformity of filling is within 0.8% as judged by replicate analyses for ^{40}Ar in powdered rock samples. Large sets of individual tracers are an alternative to the gas pipette with certain advantages, such as safety of the tracer system, flexibility, and ease of storage for indefinite periods. (auth)

2992 ALPHA: A COMPUTER PROGRAM FOR THE DETERMINATION OF RADIOISOTOPES BY LEAST-SQUARES RESOLUTION OF THE GAMMA-RAY SPECTRA. Schonfeld, E. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods, 42: 213-18 (July 1966).

A FORTRAN-63 computer program, ALPHA, was developed for the quantitative analysis of radioactive samples by the least-squares resolution of the gamma spectra. As a result of thousands of analyses, ALPHA was found to be fast, accurate, and relatively inexpensive. The main features of ALPHA are described. The program was designed to handle a small or large number of samples. The samples can have different radioactivity levels (from 0.1 to 10^4 cps), isotope compositions, and input formats. Also, they can be on cards or magnetic tape. ALPHA takes into account several corrections such as: background subtraction, counting time, decay, dead time, automatic compensation for gain and threshold shifts, sample fraction, volume reduction prior to counting, etc. Typical computation times for samples containing from 6 to 10 isotopes are about 5 to 15 sec. The cost per analysis is about 20 cents (this includes only the CDC-1604 computer charges and not the cost of sample preparation and counting). (auth)

2993 ACTIVATION TECHNIQUES IN THE MEASUREMENT OF THE ^{235}U CONTENT IN DEPLETED URANIUM. Rustichelli, F.; Maracci, G.; Bresesti, M. (CCR-EURATOM, Ispra, Italy). Nucl. Instrum. Methods, 42: 333-5(July 1966).

It is shown that the ^{235}U content in depleted uranium can be measured by activation methods to a sufficient accuracy for most practical applications. Two methods were used. In the first method pairs of 0.1-mm-thick natural uranium and 0.2-mm-thick depleted uranium foils were irradiated in the thermal column of the Ispra I Reactor. The total gamma activity of the fission products was measured after a few hours cooling. In the second method pairs of natural and depleted uranium samples were irradiated in the graphite reflector of the Ispra I Reactor. The uranium samples were wrapped in Al foils. The 1.60-Mev gamma photopeak of ^{140}La was evaluated and assumed to be proportional to the ^{235}U content. (M.C.G.)

2994 ^{235}U ENRICHMENT DETERMINATION OF LOW ENRICHED UO_2 BY GAMMA SCINTILLATION SPECTROMETRY. Yamaki, Hideo (Hitachi Ltd., Tokyo). Hitachi Rev., 15: No. 1, 2-6(Jan. 1966).

In an attempt to improve the gamma scintillation spectrometric method for determination of ^{235}U in UO_2 fuel so that accu-

rate results are obtained with a small number of standard samples, an equation was derived for the relationship between the gamma spectrum and the enrichment, utilizing the decay schemes of ^{235}U and ^{238}U and the measured values of two standard samples. When this equation was applied to two UO_2 powder samples with different enrichments, the results agreed well with the values specified by the maker. It was thus possible by gamma scintillation spectrometry to measure the enrichments of slightly enriched UO_2 powders within an accuracy of ±1.2%. Conditions of measurement are important in this procedure, and if adequate cares are taken, the method may also be applicable to solution and pellet samples. (NSA of Japan)

2995 QUALITY CONTROL ANALYTICAL METHODS IN THE INTERNATIONAL FRAME. Bergerhoff, G.; Ferraris, M.; Merten, D. (IAEA, Vienna). Z. Anal. Chem., 222: 137-43 (1966). (In German).

Intercomparisons in the analysis of radioactive nuclides in environmental media show the relation between results of many laboratories to be very bad. It is possible to improve not only the reproducibility but also the accuracy of such results by regular arrangement of intercomparisons. The 1966 program of the IAEA also includes nuclides for scientific investigations and inactive nuclides to be analyzed by activation analysis. (auth)

2996 RAPID X-RAY SPECTROCHEMICAL ANALYSIS OF CEMENT MATERIAL, USING A RI-SOURCE AND 400-CHANNEL PULSE-HEIGHT ANALYZER. Imamura, Hiroshi (Ube Kosan Co., Ltd., Japan); Tominaga, Hiroshi. FAPIG (Tokyo), No. 38, 191-5(Oct. 1965). (In Japanese).

Using a RI-source emitting α rays and soft X rays, main components (Fe, Ca, Si, Al, and Mg) of cement material were determined by an energy spectrophotometer, consisting of a proportional counter and multichannel pulse-height analyzer, without using an analyzing crystal. The measuring head employed was ^{210} Po α and $^{3}H/Zr$ x ray sources. The intensity of generated fluorescent x rays was measured by two gas-flow counters, and the pulse-height spectrum by a 400-channel PHA (pulse height analyzer). To avoid absorption loss, the source head was kept in a vacuum, and the α window was covered with a 1.5 mg/cm^2 Al foil. The 400-channel PHA, divided into two 200-channel units by anticoincidence routing, measured the spectra simultaneously, and were connected to an electronic computer, which recorded the experimental results. The sample was prepared by fusing with $Li_2B_4O_7$ and making it into a glassy disc. When the counter had an Al-filter, only the pulse height distribution of SiK x rays disappeared. Without an Al filter the pulse-height distributions of Si and AlK x rays overlapped. Ca and FeK x rays did not overlap with a Si–Al–Mg overlapped peak. Considering these points, the channel levels for the respective elements must be carefully selected for the channel integration. To stabilize the spectra, a specially designed stabilizer circuit was used. Correction for the matrix effect is possible, using the equation $N_i = a_{io} + \Sigma_j a_{ij}x_j$ by applying constants to this equation with a repeated experimental value. The standard deviations for Fe_2O_3, CaO, SiO_2, and Al_2O_3 are 0.005, 0.30, 0.19, and 0.09 wt %, respectively. (NSA of Japan)

2997 ACTIVATION ANALYZER. Suematsu, Shigeru; Suganomata, Shinji (Hitachi Ltd., Tokyo). Hitachi Hyoron, 47: No. 11, 8-14(Nov. 1965). (In Japanese).

An apparatus for activation analysis was constructed, which consists of a neutron generator of 200 keV accelerating voltage and a pneumatic tube device to convey a sample between the activation device and measuring detector. The main features of the apparatus, such as the high-voltage generator, accelerator, air exhaust mechanism, pneumatic tube, and control mechanism, are described. By the use of a pneumatic tube, a sample in a case is first sent to the neutron source and after irradiation sent back to the detector automatically. In order to use the neutron source efficiently and to lengthen the life of the target, neutrons are generated only when a sample is on the irradiation table. Some examples of activation analyses, made on uranium compounds to determine the oxygen content, using this apparatus, are given. (NSA of Japan)

2998 DETERMINATION OF THORIUM AND THE RARE EARTHS WITH TRIETHYLENETETRAMINE HEXA-ACETIC ACID (TTHA). Pribil, R. (Heyrovsky Polarographic Inst., Prague). Talanta, 13: 1711-12(Dec. 1966).

It is postulated that the structural formula of thorium-Xylenol Orange complex previously reported by Mukherji (Talanta, 13: 1185(1966)) is incorrect. Some of the reasons for questioning of the formula are (a) all metallochromic indicators must possess a grouping capable of chelate formation and joined directly to the resonant system, and (b) the steric structure of Xylenol Orange does not allow the formation of a mononuclear 1:1 complex but only a binuclear complex. (D.H.M.)

2999 DETERMINATION OF NUCLIDE CONCENTRATIONS IN SOLUTIONS CONTAINING LOW LEVELS OF RADIOACTIVITY BY LEAST-SQUARES RESOLUTION OF THE GAMMA-RAY SPECTRA. Schonfeld, E.; Kibbey, A. H.; Davis, W. Jr. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods, 45: 1-21(Nov.-Dec. 1966).

One of the most difficult and expensive analyses associated with radioactive-waste disposal is determination of the amount of each of four to ten radioactive nuclides when present only at the very low radioactivity levels of 10^2 to 10^5 pCi/l. Gamma spectrum resolution, previously developed to determine higher specific activities, based on data analysis by high speed computer was tested and found to provide a rapid, semi-automatic, reasonably accurate method for these analyses at a cost of 5 to 25 times less than that for conventional methods. The savings increase with the number of samples. Tests, with two multichannel spectrometers and data analyses by the method of least squares, using a high speed computer, were made with solutions of ^{60}Co, ^{85}Sr, ^{141}Ce, and ^{144}Ce added as tracers to water containing ^{90}Sr, ^{95}Zr-Nb, ^{106}Ru, ^{134}Cs, and ^{137}Cs. The lowest concentration of radioactivity was about one-tenth of the lowest value previously determined by this technique; that is, down to 10 cpm. Evaporation by factors up to 20 was also evaluated for improving accuracies of analyses. For comparison, the solutions were also analyzed by standard radiochemical methods. Agreement between the two methods was excellent for ^{60}Co and ^{85}Sr for concentrations down to about 500 pCi/l (scatter of ±5 to ±20%). Agreement between the two methods was good for ^{137}Cs at activities down to 3000 to 4000 pCi/l; comparative values from the two methods differed by factors of 5 to 10 for ^{144}Ce except at activities above 1600 pCi/l. More dilute solutions were successfully analyzed only if they were first concentrated by evaporation. The method is not recommended for determination of ^{106}Ru at activities below 1000 to 2000 pCi/l, unless this nuclide constitutes a major fraction of the total activity and ^{85}Sr is a minor component. Several contributions to the mathematical techniques of gamma spectrum resolution are reported. These include: data showing that gain shifts up to 5% and threshold shifts of two channels can be accurately handled by a computer program; resolution of the errors of concentration estimates into contributions by background and the various radioactive species present; and use of χ^2 to test the overall reliability of the multichannel spectrometer. (auth)

3000 CATION EXCHANGE STUDIES OF THALLIUM(I) ON DOWEX 50W-X 8; SEPARATION FROM MIXTURES. Rangnekar, Asha V.; Khopkar, S. M. (Indian Inst. of Tech., Bombay). Indian J. Chem., 4: 318-20(July 1966).

The cation exchange chromatographic behavior of milligram amounts of Tl(I) on Dowex 50W-X 8 (H form) was studied. Sulfuric acid, perchloric acid, sodium sulfate, and ammonium acetate are capable of desorbing 20.34 mg of Tl(I) from 1.4 cm × 19 cm bed. Tl(I) was separated from Cu, Cd, Al, Zn, Mn, Co, Ni, U, V, Ag, and Pb by selective elution. Anionic complexation with EDTA and citric acid was used for the separation of Tl(I) from Zr, Ce, Ba, Th, Bi, and Fe. The separation of Tl(I) from Sb and Sr was effected by taking advantage of the elution of these ions with 5 per cent citric or tartaric acids; Tl(I) was recovered later by elution with 4M sulfuric acid after washing the column free of anions with water. (auth)

3001 PARTICULAR PROBLEM IN CONNECTION WITH THE COUNTING OF ^{14}C-LABELED ORGANIC MOLECULES BY LIQUID SCINTILLATION. Krotoszyner, J. P. (Institut Agronomique, Gembloux, Belg.); Dulcino, J.; Kirchmann, R. Mededel. Landbouwhogeschool Opzoekingsstat. Staat Gent, 30: 1283-93(1965). (In French).

Some of the difficulties encountered in assaying ^{14}C-labeled sucrose, by liquid scintillation counting, which gave abnormally low values, and of their correction, are discussed. The scintillators used consisted of 2,5-diphenyloxazole at a concentration of 10 g/l in toluene and 2,2′-p-phenylene-bis-(5-phenyloxazole) at a concentration of 250 mg/l in toluene. The ^{14}C-sucrose was originally dissolved in alcohol (90° ethanol) which was believed to permit thorough dissolution of the sugar in toluene. The chemical or dye quenching occurring in liquid scintillation counting is usually detected by the pulse-height shift or by the internal standard method. However, incomplete dissolution of the labeled compound in the scintillation medium results in a low counting efficiency which cannot be detected by the above-mentioned methods. It was found that the use of 94° ethanol instead of absolute ethanol reduces to one-third the counting efficiency of sucrose-^{14}C dissolved in a 0.3% alcohol/toluene solvent. It is emphasized that it is extremely important to choose the appropriate solvents to avoid any source of efficiency decrease which could not be detected by the routine methods of quenching evaluation. (BBB)

3002 A CONTRIBUTION TO THE QUANTITATIVE ACTIVATION ANALYSIS DETERMINATION OF PURITY OF THE RARE EARTH OXIDES. Bildstein, H.; Auer-Welsbach, Helga (Oesterreichische Studiengesellschaft fuer Atomenergie, Vienna). Monatsh. Chem., 97: 905-10(1966). (In German).

Quantitative determination of Eu in Gd, Pr in Nd, and Lu in Yb was performed by activation of the samples followed by separation on the cation exchanger Dowex 50W X8. Complete separation in the systems Eu–Gd and Pr–Nd was achieved with aqueous ammonium α-hydroxyisobutyrate solutions. Ammonium lactate gave better results with Yb and Lu. In all cases the reproducibility of the position of the elution peaks was satisfactory. Using this separation technique the residual impurities in the samples analyzed were estimated to be 0.065 μg $EuO_{1.5}$/mg $GdO_{1.5}$; 1.2 μg $PrO_{1.83}$/mg $NdO_{1.5}$, and 1.5 μg $LuO_{1.5}$/mg $YbO_{1.5}$, respectively. (BBB)

3003 DETERMINATION OF TRACE QUANTITIES OF XENON IN ARGON BY GAS CHROMATOGRAPHY. Haviena, E. J. Jr.; Hutchinson, K. A. (Detroit Edison Co.). J. Gas Chromatogr., 4: 380-3(Oct. 1966).

A method was developed for the determination of trace quantities of Xe in Ar or in other gases by gas chromatography. A large sample of Ar gas is allowed to flow through a charcoal-molecular sieve 5A cold trap, 1½ ft long and ¼ in. OD, maintained at –78°C. The absorbed Xe is transferred to a gas chromatograph by warming the cold trap and is determined in the conventional manner. One millimeter of peak height is equivalent to 3.10×10^{-5} ml of Xe. Peak height was linear over the investigated concentration range, 3.10×10^{-5} to 5×10^{-3} ml of Xe. Using the described procedure, the determination of Xe in reactor grade Ar was attempted. The results of the analysis indicated that less than 0.002 ppM by volume of Xe was present. Since, in a nuclear reactor, the interest is greater in radioxenon (^{133}Xe, $T_{½}$ = 5.3 days), a procedure to separate Xe gas chromatographically and to determine the activity using a vibrating reed electrometer was worked out. In the procedure described, a sample of reactor cover gas to which nonradioactive Xe may be added as a carrier is collected on the trapping column, transferred to the chromatographic column, and separated. The Xe fraction is collected in a vibrating reed electrometer chamber and its activity determined. Attempts to determine radioxenon in reactor cover gas were inconclusive. (TCO)

3004 RADIOCHEMICAL DETERMINATION OF METALLIC MERCURY VAPOR IN AIR. Magos, L. (Medical Research Council Labs., Carshalton, Eng.). Brit. J. Ind. Med., 23: 230-6(July 1966).

A radiochemical method was developed for the estimation of atmospheric mercury. When air containing mercury is passed through a solution of ^{203}Hg–mercuric acetate and KCl, isotope exchange takes place so that the issuing air contains the same concentration of mercury, but labeled and with the same specific activity as the reagent solution. The ^{203}Hg is absorbed on hopcalite and estimated by γ-scintillation counting. The standard deviation is 0.004 μg/l in concentrations up to 0.2 μg Hg/l, and is 0.075 μg Hg/l in the range 0.2 to 1.2 μg Hg/l concentration. The method is simple and can be used for snap or long-run sampling, and with continuous recording. It has the advantage over other methods which detect metallic mercury vapor in that it avoids the contamination of air with radiomercury. The method described is more accurate than chemical methods, and flexible. Unlike the situation in estimations by mercury vapor meters, the sampling and determination are not necessarily connected, and, as a result, many parallel samples can be taken at the same time. In addition, there is nothing equivalent to the drift of the zero point in prolonged tests which can disturb estimations with mercury vapor meters. (BBB)

3005 ESTIMATION OF ARSENIC IN BIOLOGICAL MATERIALS BY NEUTRON ACTIVATION ANALYSIS. Krishnan, S. S.; Erickson, N. E. (Center for Forensic Science, Toronto). J. Forensic Sci., 11: 89-94(Jan. 1966).

A neutron activation method was developed for determining As in biologic materials. In criminal cases involving alleged arsenic poisoning, the estimation of arsenic in biological materials is important to forensic toxicologists. When only small quantities of samples such as hair, tissue, or nail clippings are available, a very sensitive method for detection of arsenic is necessary. The neutron activation analysis procedure involves irradiating the sample, then dissolving it in a mixture of sulfuric acid, nitric acids, and perchloric acid, separating the arsenic, and estimating the radioactivity of ^{76}As present using normal γ counting techniques. The amount of arsenic is calculated by comparing the counts obtained from the sample with those obtained from an arsenic oxide standard which is irradiated simultaneously with the sample and then treated in the same way. The lower limit of detection of arsenic by this method is 10^{-10} g, using a thermal neutron flux of 10^{13} neutrons/sec/cm^2. A rapid ion-exchange separation technique was developed and incorporated in the neutron activation method. The acid-digested residue is taken up in 0.0005 M sulfuric acid, passed through a cation exchange column, and the ^{76}As determined in the eluent by scintillation counting. A greatfold increase in speed over the existing methods for the separation of arsenic after acid digestion has been obtained. The apparatus is simple and interference due to incomplete destruction of organic matter does not introduce any appreciable error in this method. (BBB)

3006 DETERMINATION OF EXTRATHYROIDAL IODINE BY NEUTRON-ACTIVATION ANALYSIS. Kertesz, L.; Csajka, M. (Univ. Medical School, Debrecen, Hung.). Acta Biochim. Biophys., Acad. Sci. Hung., 1: 187-96(1966).

An improved more accurate method was developed whereby neutron activation analysis was used for the determination of stable iodine in biological samples. The aim of the experiments was to create better conditions for the determination of specific activity values in isotope kinetic studies, eliminating the discrepancy between the sensitivities in measurements of radioactive and inactive iodine. In samples of extrathyroid rat tissues, iodine was estimated with an accuracy of 10^{-9} g. This sensitivity can be enhanced by increasing the neutron flux and by partial automatization. The chemical separation of the activated iodine was completed after irradiation. The γ-spectrometric evaluation was facilitated by the fact that the ^{128}I isotope in the sample was prepared radiochemically pure for the measurements by the separation of cuprous iodide by precipitation. A method of isotopic double labeling was accomplished: iodine content of such samples was determined by activation in which the incorporation of other radioiodine isotopes (^{131}I and ^{125}I) was measured previously. (BBB)

3007 LOW ENERGY ^3He ACTIVATION ANALYSES FOR CARBON AND OXYGEN. Gorodetzky, S.; Pape, A.; Chevallier, A.; Sens, J. C.; Armbruster, R. (Institut de Recherches Nucleaires, Strasbourg). Nucl. Instrum. Methods, 42: 269-72(July 1966).

The possibility of using ^3He ions accelerated to kinetic energies below 5.5 MeV in activation analyses for carbon and oxygen was investigated. Radiations from ^{11}C and ^{18}F produced in the ^3He bombardments of carbon and oxygen, respectively, were used to detect the presence of these elements. Using the stacked foil method with targets of known composition, the cross sections for the $^3He + C \rightarrow {}^{11}C$ and $^3He + O \rightarrow {}^{18}F$ reactions were measured as a function of energy up to 5.5 MeV. The results show that both reactions have cross sections in the tens of mb at a ^3He laboratory energy as low as 2 MeV. The $^3He + N \rightarrow {}^{13}N$ reaction, which can serve as the detecting reaction for nitrogen, was determined to have much lower cross sections. (auth)

3008 PROCEEDINGS OF THE CONFERENCE ON APPLICATION OF PHYSICO-CHEMICAL METHODS IN THE CHEMICAL ANALYSIS HELD IN BUDAPEST, 20–23, APRIL 1966. VOLUME II. Buzas, Ilona (ed.). Budapest [Technical Univ. Hungarian Chemical Society], 1966. 554p. (CONF-660413–(Vol.2)).

Sixty-two articles are included. Twenty-five of them deal with chromatographic analyses, thirty-seven with radiochemistry and activation analyses. (J.G.B.)

3009 APPARATUS FOR ACTIVATION ANALYSIS. Iwashita, Fumio (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1965-21680. July 26, 1965. Filed May 30, 1963.

In activation analysis apparatus, it is necessary to transport a sample very rapidly between the radiation source and the measuring device, and for this purpose a pneumatic tube is usually used. The material is placed in a rabbit case in the tube. The background due to the activation of the case material is a problem in the measurement. In the apparatus proposed, such an adverse effect due to the rabbit-case activation is removed. The apparatus consists of a radiation source, detector, pneumatic tube connecting the two, and a rabbit case at least twice as long as the length of a sample material. (NSA of Japan)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 2998, 3088, 3116, 3462, 3475, and 3539.

3010 (AERE-M-1593) OUTGASSING OF BULK URANIUM AND PLUTONIUM CARBIDES. Evered, S.; Moreton-Smith, M. J.; Sowden, R. G. (Atomic Energy Research Establishment, Harwell (England)). Apr. 1965. 10p. Dep. mn.

The outgassing of bulk carbides following storage in various at-

mospheres was investigated. The main product of vacuum outgassing at temperatures up to 1000°C is hydrogen, which presumably arises from hydrolysis by chemisorbed water. Only small amounts of gas (less than $50\mu lg^{-1}$) are evolved from dense carbide stored in a pure argon atmosphere (<20 ppM H_2O, <50 ppM O_2) for periods up to six weeks. (auth)

3011 (AWRE-O-60/66) X-RAY EXAMINATION OF TITANIUM HYDRIDE. Jones, P. M. S.; Ellis, P.; Smith, J. R.; Aslett, T.; Hutcheson, C. G. (Atomic Weapons Research Establishment, Aldermaston (England)). Aug. 1966. 12p. Dep. BIS $0.40. HMSO 2s.

Results are given of x-ray examination of Ti–H alloys by both the Debye–Scherrer and diffractometer methods. It is found that the hydrogen-deficient hydride phase appears when the atomic ratio H/Ti falls to 1.37 ± 0.03. (auth)

3012 (AWRE-O-72/66) OXIDATION OF RARE EARTH METALS. PART 2. PRASEODYMIUM. Jones, P. M. S.; Edmondson, W. (Atomic Weapons Research Establishment, Aldermaston (England)). Oct. 1966. 12p. Dep. BIS $0.50. HMSO 2s. 6d.

The oxidation of praseodymium foil in pure oxygen is found to have a rate directly proportional to the oxygen pressure after the initial parabolic reaction stage. The data are interpreted as showing that the oxide protective layer reaches a limiting thickness which is greater at higher temperatures; thereafter the oxide barrier becomes porous at the outer layers at a rate comparable to the rate of fresh oxide production. The activation energy for the reaction is 27 kcal/mole which is comparable to the value for the diffusion of oxygen through the oxide in the parabolic stage of the reaction. (auth)

3013 (IS-T-121) KINETICS OF THE OXIDATION OF THULIUM BY OXYGEN AND WATER VAPOR. Rider, Thomas John (Ames Lab., Iowa). Aug. 1966. Contract W-7405-eng-82. 86p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

An examination was made of the kinetics of the reaction of thulium with oxygen, water vapor, and mixtures of the two in the temperature range 650 to 850°C at varying pressures. The reaction was studied gravimetrically as a function of time, temperature, and pressure. In general the data was found to obey a parabolic rate law, although there was some indication of a linear law at lower temperatures and a cubic law at the highest temperatures. The water vapor reaction was found to liberate a gas, probably hydrogen. By using the Arrhenius equation the activation energies were calculated as 28.0 kcal/mole for reaction with oxygen at 11 to 12 Torr, and 29.0 kcal/mole for reaction with water vapor to 18 to 19 Torr. These values indicated a possible similar mechanism for the two reactions. Data also indicated that inward diffusion of oxygen is the rate controlling factor. The reaction between thulium and mixtures of oxygen and water vapor was found to be more complex. Three different thulium rods were used in the investigation and one of them behaved differently from the other two. Rods I and II gave a highly accelerated rate of reaction with 13 Torr each of oxygen and water vapor between 732 and 768°C, while rod III did not. Photomicrographs of the three rods disclosed that the surfaces of rods I and II were granular at 250 X, while rod III had a relatively homogeneous surface. Rod III was also found to contain more oxygen as an impurity than rods I and II. These facts probably account for the difference in behavior of the three rods. X-ray powder pattern analysis of the coating of a thulium sample that had given an accelerated rate of reaction showed the coating to be Tm_2O_3. Since this pattern was taken sometime after the reaction, the possibility of an unstable thulium hydride in the coating was not ruled out. (auth)

3014 (NP-16328) STUDY OF URANIUM(IV) NITRATE AS REDUCING AGENT FOR PLUTONIUM. IIa. STABILITY OF URANIUM(IV) IN SOLUTION. Lopez-Menchero, E.; Salomon, L.; Bardone, G. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). Mar. 1966. 69p. (ETR-181). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The stability of uranium(IV) nitrate was studied in an aqueous nitric acid phase, in an organic phase (30% TBP in SST), and in an emulsion of an aqueous phase with an organic phase. The study was related to the data for the use of uranium(IV) as reducing agent for plutonium(IV) in a U–Pu partition cycle of the Eurochemic separation flowsheet. It was found that aqueous nitric acid solutions of uranium(IV), by themselves very unstable, can be made very stable by the addition of hydrazine in a suitable quantity. On the other hand, in the organic phase the oxidation that takes place and that is 100 to 1000 times faster than that in the aqueous phase stabilized with hydrazine, remains just as fast (and is often faster) when this organic phase is put into contact with an aqueous phase containing hydrazine. An important result was the stabilization of uranium(IV) nitrate in the organic phase or in an emulsion, when an inert atmosphere was used. Absence of light was very favorable to the stability. (auth)

3015 (RT-CHI-(66)-12) PREPARATION OF THORIUM–URANIUM DICARBIDE PARTICLES BY SOL-GEL METHOD. Cogliati, G.; Maltzeff, P.; Mezi, E.; Recrosio, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 10p. (CONF-660318-1). Dep. mn.

From Dragon Contractors' Research and Development Symposium, Harwell, England.

The preparation of thorium–uranium dicarbide particles by the sol-gel method is described. Spherical particles of thorium–uranium oxide mixed with dispersed carbon, are obtained by the extraction of nitric acid by means of a liquid anionic exchanger, both for the preparation of the colloidal solution and for the gelation of the sol drops. Variations of viscosity with concentration of thorium–uranium colloidal solution at different $NO_3^-/Th + U$ ratios were measured. Thorium–uranium dicarbide particles are prepared by carburizing under vacuum the UO_2 + C particles. (auth)

3016 (SC-RR-66-584) DECOMPOSITION KINETICS OF THE PHENOLIC-CARBON CLOTH FM 5055A ABLATOR. I. RATE-CONTROLLING REACTION: COMPLEX SECOND ORDER. Auerbach, Irving (Sandia Corp., Albuquerque, N. Mex.). Nov. 1966. Contract AT(29-1)-584. 30p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An isothermal kinetic study was conducted on the decomposition of the phenolic-carbon cloth FM 5055A ablator over the temperature range from 104 to 718°C, and at pressures of 0.1 to 0.2 torr. The results were fitted to a modified second-order kinetic expression describing the decomposition. A plot of the equilibrium constant versus temperature provided the enthalpy change for two temperature ranges. These values were correlated with specific reactions in the decomposing resin. An Arrhenium plot for the rate constants and temperature showed that four distinct temperature ranges exist in which the rate constants, and the effect of temperature on the rate constants, differ. (P.C.H.)

3017 GENERALIZED MEAN-SQUARE AMPLITUDES OF VIBRATION AND SHRINKAGE EFFECT IN $CF_3C:CH$ AND $CF_3C:CD$. Venkateswarlu, K.; Mathew, Mariamma P. (Kerala Univ., India). Curr. Sci. (India), 35: 562(Nov. 20, 1966).

Symmetry coordinates of methyl acetylenes were used in determining the generalized mean-square amplitudes of vibration in $CF_3C:CH$ and $CF_3C:CD$ which are tabulated. Shrinkages were calculated and tabulated. Substitution of deuterium decreased the mean amplitude and shrinkage values. (J.G.B.)

3018 STEREOCHEMISTRY OF SULFOXIDE IN THE BASE-CATALYZED HYDROGEN-ISOTOPIC EXCHANGE OF ARYL-METHYL SULFOXIDE. Khim, Yong-he; Tagaki, Waichiro; Kise, Masahiro; Furukawa, Naomichi; Oae, Shigeru (Osaka City Univ.). Bull. Chem. Soc. Japan, 39: 2556-7(Nov. 1966).

Optically-active p-totyl methyl sulfoxide was subjected to base-catalyzed hydrogen isotopic exchange in various solvents in order to study the possible racemization, along with the H–D exchange or the methyl group attached to the sulfoxide. From ultraviolet absorption, infrared and NMR spectroscopic analysis, and melting point the recovered sulfoxide was found to be identical with the starting sulfoxide, except that the recovered sulfoxide was found to have incorporated a considerable amount of deuterium at the methyl group. The configuration around the sulfur atom of the trivalent sulfur group was retained regardless of solvent. These observations appear to suggest strongly that the carbanion attached to a trivalent sulfur group such as sulfoxide is stabilized by the resonance involving the 2p-orbital of carbon and the 3d-orbital of sulfur. (D.H.M.)

3019 ISOTOPIC EFFECT OF OXYGEN IN H_2O_2* SYNTHESIS FROM H_2O* VAPOR IN GLOWING DISCHARGE. Volnov, I. I.; Chomova, V. N.; Salimova, K. M.; Latysheva, E. I. (Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Zh. Fiz. Khim., 40: 2349-51(Sept. 1966). (In Russian).

During the synthesis of $H_2O_2^*$ from H_2O^* vapor (containing up to 37.5 at. % ^{18}O) in glow discharges, the peroxide was enriched with the ^{18}O isotope. The enrichment coefficient was 1.07. With determination of the isotopic balance, the phenomenon detected agrees with the representation of the mechanism of the formation of H_2O_2 and H_2O in glow discharges. The peroxide is enriched in ^{18}O because it is formed on the wall of the trap, principally through $H^{18}O_2$; the water is impoverished in ^{18}O because it is formed in the gaseous phase, principally by the recombination of ^{16}OH radicals. (tr-auth)

3020 EXISTENCE OF GASEOUS URANIUM MONOPHOSPHIDE. Gingerich, Karl A. (Battelle Memorial Inst., Columbus, Ohio). Naturwissenschaften, 53: 525(1966).

Mass spectrometric studies were made of the vaporization of uranium phosphide in order to detect the gaseous monophosphide molecule. At 2270°K UP (mass 269) was first observed. The abundance of ^{235}U was too low for cross checking the identification of the UP. The molecular beam distribution checked on neighboring peaks showed no extraneous contribution to the peak intensity of UP. At 2270°K the ion current intensity for UP^+ was 3.3×10^{-5} of that of either U^+ or P^+, the principal vapor components. This ratio increased to 7.7×10^{-5} at 2370°K. The measurements correspond to an electron energy of 30 eV. The appearance potential of UP as measured by the linear extrapolation method, taking a value of U of 6.11 as standard, is 7.3 ± 0.4 eV. (D.H.M.)

3021 REACTION OF PHENOTHIAZINE AND ITS DERIVATIVES WITH RADIOACTIVE ^{35}S. Khodzhaeva, I. V.; Kavun, S. M.; Sapozhnikova, M. M.; Eitingon, I. I. (Moscow Inst. of Fine Chemical Tech.). Zh. Fiz. Khim., 40: 2041-5(Sept. 1966). (In Russian).

Aromatic thioamines, containing one atom of sulfur (thiodiphenylamine, phenyl-α-thiodiphenylamine, phenyl-β-thiodiphenylamine, and phenyl-β-oxythiodiphenylamine) do not exchange or interact with labeled sulfur at temperatures below 175°C. At 175°C thermal decomposition of the aromatic thioamines occurs, accompanied by the separation of hydrogen sulfide. Sixty to seventy percent of the sulfur is isolated in the form of H_2S. Dithiophenyl-β-naphthylamine reacts with ^{35}S at all temperatures studied from 120 to 175°C. At 175°C decomposition of the dithiophenyl-β-napthylamine begins with the separation of H_2S. Apparently, dithiophenyl-β-naphthylamine adds sulfur with subsequent isotopic exchange of the tri- and polysulfide formed. The addition of sulfur was confirmed by the effect of bathochrome displacement of the UV absorption spectrum maximum of the products from the interaction of dithiophenyl-β-naphthylamine with sulfur. (tr-auth)

3022 TWIN-ELECTRODE THIN-LAYER ELECTROCHEMISTRY. KINETICS OF SECOND-ORDER DISPROPORTIONATION OF URANIUM(V) BY DECAY OF STEADY-STATE CURRENT. McDuffie, Bruce; Reilley, Charles N. (Univ. of North Carolina, Chapel Hill). Anal. Chem., 38: 1881-7(Dec. 1966).

The method of steady-state current decay with a twin working-electrode thin-layer cell, applied earlier to a kinetic study of a first-order following reaction, was extended to the case of a second-order coupled reaction, using the disproportionation of uranium(V) as the model system. A general rate equation for decay of the steady-state current is derived for the second-order case and compared with experimental data on the uranium system. Rate data at several different acidities and initial U(VI) concentrations are in reasonable agreement with previous work and with the proposed second-order mechanism. Limitations of both the chemical system and the steady-state decay method on the range of determinable second-order rate constants are discussed. (auth)

3023 BASE-CATALYZED HYDROGEN–DEUTERIUM EXCHANGE IN BIVALENT METAL–EDTA CHELATES. Terrill, J. B.; Reilley, C. N. (Univ. of North Carolina, Chapel Hill). Anal. Chem., 38: 1876-81(Dec. 1966).

The hydrogen–deuterium exchange in alkaline heavy water solutions at 95°C of bivalent metal-(ethylenedinitrilo)-tetraacetates (EDTA) was followed by nuclear magnetic resonance (NMR) spectrometry by observing decreases in spectral intensities. The exchange process, studied in 0.1 to 0.8M OD^-, was first order in complex and first order in OD^-. The order of reactivity of the metal chelates, $Cu^{2+} > Ni^{2+} > Co^{2+} > Zn^{2+} > Pb^{2+} > Cd^{2+} > Mg^{2+} > Ca^{2+} > Sr^{2+} > Ba^{2+}$, correlates well with the strength of the metal-ligand bonds. Only the acetate methylene protons exchanged at a measurable rate. In similar studies with unassociated model compounds, a much slower OD^- hydrogen-deuterium exchange was observed for acetate and glycinate; in contrast, the exchange rates for imidodiacetate (IDA), ethylenediamine–N,N′–diacetate (EDDA), and EDTA were faster and were zero order in OD^-, suggesting an intramolecular base-catalysis process. (auth)

3024 NORMAL COORDINATE ANALYSIS OF CF_3–CH_3 AND CF_3–CD_3. Lafon, Barbra; Nielsen, J. Rud (Univ. of Oklahoma, Norman). Contract AT(40-1)-1074. J. Mol. Spectros., 21: 175-82(Oct. 1966).

To correct an error in previous work, a new normal coordinate analysis was made of 1,1,1-trifluoroethane. The analysis, based on a Urey–Bradley potential function, was extended to the deuterated isomer, CF_3-CD_3. (auth)

3025 ANHYDROUS SODIUM POLYURANATES. Carnall, W. T.; Walker, A.; Neufeldt, S. J. (Argonne National Lab., Ill.). Inorg. Chem., 5: 2135-40(Dec. 1966).

The structure of anhydrous mixed uranium oxide–sodium oxide phases in which the ratio $UO_3 : Na_2O$ varied from 2 to ~ 13 was investigated using x-ray powder patterns and infrared absorption spectra. A phase with the approximate composition $Na_2O \cdot 13UO_3$ was identified and found to be stable at high temperatures. Its cell parameters were found to be closely related to those for U_3O_8 and α-UO_3. A second, $Na_2U_2O_7$-related phase was also identified. (auth)

3026 CALCULATION OF KINETIC ISOTOPE EFFECTS FOR THE REACTION OF METHYL IODIDE WITH CYANIDE IONS. Willi, A. V. (Brookhaven National Lab., Upton, N. Y. Columbia Univ., New York). Contract AT(30-2)-Gen-16. Z. Naturforsch., 21a: 1377-84(Sept. 1966). (In German). (BNL–9925).

Kinetic ^{13}C and deuterium isotope effects were calculated for the S_N2 reaction of CH_3I with CN^-. The normal vibrational frequencies of CH_3I, the transition state $I\cdots CH_3\cdots CN$, and the corresponding isotope substituted reactants and transition states were evaluated from the force constants by solving the secular equation on an IBM 7094 computer. Values for 7 force constants of the planar CH_3 moiety in the transition state (with an sp^2 C atom) were obtained by comparison with suitable stable molecules. The stretching force constants related to the bonds being broken or newly formed (f_{CI}, f_{CC}, and the interaction between these two stretches, f_{12}) were chosen in such a way that either a zero or imaginary value for $\nu_1^{\prime}$ will result. Agreement between calculated and experimental methyl-^{13}C isotope effects (k_{12}/k_{13}) can be obtained only in sample calculations with sufficiently large values of f_{12} which lead to imaginary $\nu_1^{\prime}$ values. Furthermore, the difference between f_{CI} and f_{CC} must be small (in the order of 1 mdyn/Å). The bending force constants, f_{HCI} and f_{HCC}, exert relatively little influence on k_{12}/k_{13}. They were important for the D isotope effect. As soon as experimental data on k_H/k_D are available it will be possible to derive a value for f_{HCC} in the transition state if f_{HCI} is kept constant at 0.205 mdynÅ, and if f_{CI}, f_{CC} and f_{12} are held in a reasonable order of magnitude. There is no agreement between experimental and calculated cyanide-^{13}C isotope effects. Possible explanations are discussed. Since f_{CI} and f_{CC} cannot differ much it must be concluded that the transition state is relatively "symmetric," with approximately equal amounts of bond making and bond breaking. (auth)

3027 CALCULATION OF KINETIC ISOTOPE EFFECTS FOR THE REACTION OF METHYL IODIDE WITH HYDROXIDE IONS. Willi, A. V. (Brookhaven National Lab., Upton, N. Y. Columbia Univ., New York). Contract AT(30-2)-Gen-16. Z. Naturforsch., 21a: 1385-90(Sept. 1966). (In German). (BNL–9924).

Kinetic ^{13}C deuterium, and ^{18}O isotope effects were calculated from force constants for the S_N2 reaction of CH_3I with OH^-. The secular equations for the vibrational frequencies of reactants and transition states were solved on an IBM 7094 computer. Values for 7 force constants of the planar CH_3 moiety in the transition state (with an sp^2 atom) were obtained by comparison with suitable stable molecules. The stretching force constants $f_{CO} = f_{11}$, $f_{CI} = f_{22}$, and f_{12} in the transition state were chosen as linear functions of x, the degree of bond making and bond breaking. The carbon isotope effect as a function of x exhibited a flat maximum near x = 0.6. If the bending force constants f_{HCO} and f_{HCI} were kept constant, k_{12}/k_{13} was significantly lower than its maximum value only for values of $x \leq 0.3$ and $x \geq 0.8$. There was only a small influence of x on the deuterium isotope effect, k_H/k_D (compare rates of CH_3I and CD_3I). However, k_H/k_D was strongly dependent on f_{HCO} and f_{HCI}. The oxygen-18 isotope effect decreased with increasing x. Experimental data of the D isotope effect, if they were available, could be used to adjust the bending force constants f_{HCO} and f_{HCI} (or to adjust f_{HCO} if f_{HCI} is held constant). The degree of unsymmetry of the transition state could then be estimated with the aid of the C isotope effect. Experimental data of the O isotope effect would supply information on the direction of the unsymmetry, which is needed for a distinction between 2 possible values of x. There is approximate agreement between the calculated and the experimental temperature dependence of the ^{12}C isotope effect. (auth)

3028 KINETIC OXYGEN AND HYDROGEN ISOTOPE EFFECTS IN THE HYDROXIDE ION CATALYZED REACTION OF 2,4-DINITROPHENYL PHENYL ETHER WITH PIPERIDINE IN AQUEOUS DIOXANE. Hart, C. R.; Bourns, A. N. (McMaster Univ., Hamilton, Ont.). Tetrahedron Lett., No. 26, 2995-3002 (July 1966).

The kinetic oxygen isotope effect results for the reaction of 2,4-dinitrophenyl phenyl ether with piperidine at 0° in 40% water–60% dioxane by volume in the presence of varying concentrations of hydroxide ion are reported. Also, data on the dependence of the deuterium solvent isotope effect on hydroxide ion concentration are presented and discussed in relation to the mechanism of the base-catalyzed step of the process. Under the conditions chosen for the study, nucleophilic attack of hydroxide ion giving 2,4-dinitrophenol accounts for less than 2% of the total reaction. Furthermore, neither uncatalyzed nor piperidine-catalyzed processes make a sig-

nificant contribution over the range of hydroxide ion concentration used in the isotope effect experiments. The oxygen isotope effects were determined by comparing the ratio $^{16}O:^{18}O$ in the product, phenol, formed from a reaction carried to completion to that of the product of reactions carried to some known extent ranging from 10 to 34%. The reactant contained ca 5% ^{18}O in the ether position. Isotopic analyses were made on phenol itself using a simultaneous collection mass spectrometer. The results are in accord with the predictions of the intermediate complex mechanisms which are outlined. It was possible to calculate k^{16}/k^{18}, the isotope effect for the carbon–oxygen bond rupture step, from the observed isotope effect at any given hydroxide ion concentration. The values so obtained for the two base concentrations of 0.005 and 0.033 M, at which the observed effect is appreciable, were 1.0124 and 1.0133. The agreement, which is well within experimental error, lends further support for the mechanism upon which the calculations have been based. (TCO)

3029 DIFFUSION OF URANIUM HEXAFLUORIDE IN SOME OTHER GASES. Ljunggren, Stig (Uppsala Univ.). Arkiv Kemi, 24: 1-46(1965).

Experiments are reported on the diffusion of uranium hexafluoride at a low concentration in inert gases and in a few light homonuclear diatomic gases. A Loschmidt-type diffusion cell was constructed in which the upper half-cell slides on the lower half-cell. To perform an experiment the two half-cells are slid apart and evacuated. Uranium hexafluoride is then introduced into the lower half-cell until its pressure reaches a predetermined value and then both half-cells are brought up to atmospheric pressure by feeding in the lighter gas. After equilibrium is established the two half-cells are made to coincide after which the diffusion starts. The diffusion is followed by recording the refractive index variations at a certain level of the cell, using a Twyman-Green interferometer. Stainless steel, neoprene, and phosphate glass were used for various parts of the cell. The binary diffusion coefficients of UF_6 in He, Ne, Ar, Kr, Xe, H_2, and O_2 were determined at 20°C. Possible sources of errors including inverse thermal diffusion, nonconstant number density, and optical aberrations were investigated in detail and found to be negligible. (BBB)

3030 PROTON RESONANCE INVESTIGATIONS IN AROMATIC HETEROCYCLES. III. INVESTIGATIONS OF THE H/D EXCHANGE IN AZOLES AND AZOLIUM SALTS. Staab, Heinz A.; Irngartinger, Hermann; Mannschreck, Albrecht; Wu, Mouthai (Univ., Heidelberg). Ann. Chem., 695: 55-64(1966). (In German).

The NMR spectra of several imidazoles and oxazoles were measured and the chemical shifts ordered. In light of these measurements the rates of H–D exchange at various positions were studied. A 1% solution of 4-nitroimidazole heated 13.5 hr to 100°C showed D incorporation at positions 2 and 4 in the ratio 5:3; in 0.8M NaOD in D_2O after 12 hr showed complete exchange with these positions. After 12.5 hr in D_2O (2.5% solution) at 100°C, 1-methyl-4-nitroimidazole is 90% exchanged at H-5 and 50% at H-2; 1-methyl-5-nitroimidazole is 100% exchanged at H-2 and 10% at H-4. The half life of the exchange of the H-2 in 4,5-di-n-propyloxazole in CH_3OD at 60°C is 600 min, of 4,5-diphenyloxazole at 69°C is 1100 min; while 3-methyloxazolium iodide in CH_3OD at 37°C is completely exchanged at the 2 position in 3 min. The dependence of relative exchange rates on structure is discussed in connection with biochemical questions. (BBB)

3031 HIGH-TEMPERATURE REACTIONS IN TiC–ZrO_2 SYSTEMS. Gropyanov, V. M.; Yudin, B. F.; Avgustinik, A. I. (All-Union Inst. of Refractory Materials, USSR). Ogneupory, No. 10, 50-5(Oct. 1966). (In Russian).

Chemical reactions in TiC–ZrO systems at 1700 to 2400°K in a vacuum at 5×10^{-4} mm Hg have a complex character and depend on the ratio of the initial material components, temperature, and gas medium. (R.V.J.)

3032 INVESTIGATIONS OF CHLORINE COMPOUNDS OF GROUP IV. THORIUM TETRACHLORIDE ADDITION COMPOUNDS WITH ACETONITRILE, BENZONITRILE, AND DIOXANE, AND THE COMPOUND $ThOCl_2.CH_3CN$. Feltz, A. (Friedrich-Schiller-Univ., Jena, Ger.). Z. Chem., 6: 318(Aug. 1966). (In German).

The addition compounds $ThCl_4 \cdot 4CH_3CN$, $ThCl_4 \cdot 4C_6H_5CN$, and $ThCl_4 \cdot 3C_4H_8O_2$ were prepared from $ThCl_4$ and the appropriate Lewis bases; they are slightly soluble in the excess Lewis base. The C_6H_5CN complex may be crystallized from C_6H_5CN; the other compounds may be prepared in pure form from this complex. The reaction of $(C_2H_5)_4NCl$ and $ThCl_4$ in CH_3CN gives $[(C_2H_5)_4N]_2ThCl_6$. No pentachloro complex was observed. The ir spectrum of $ThCl_4 \cdot 4CH_3CN$ has an absorption at 2280 cm^{-1}, shifted to shorter wavelengths than the free compound; thus all CH_3CN is coordinatively bound and Th is surrounded by 8 ligands. Thermal decomposition begins at 70°C and proceeds without intermediate stages to $ThCl_4$. Partial hydrolysis of $ThCl_4 \cdot 4CH_3CN$ in CH_3CN ($H_2O:ThCl_4 \cdot 4CH_3CN = 1:1$) gives $ThOCl_2 \cdot CH_3CN$. With a lower ratio, a mixture of this and the starting material is formed. The CH_3CN is relatively strongly bound and is completely removed in vacuum only above 200°C. (BBB)

3033 HIGH REFRACTORY MATERIALS WITH ZIRCONIUM DIOXIDE BASE STABILIZED BY RARE EARTH OXIDES. Kind, N. E.; Koshur, L. T. Ogneupory, No. 10, 55-8(Oct. 1966). (In Russian).

Thermal analysis of ZrO_2 stabilized with CeO_2 or Y_2O_3 showed a minimum expansion, and the highest thermal resistance was in specimens containing 11% mole CeO_2. Further increase of CeO_2 to 15 and 28% mole weakened the thermal resistance of the mass. Additions of Y_2O_3 produced relatively good effects, but additions of LaO_2 were much less effective. The highest thermal stability was achieved with specimens containing ZrO_2 in cubic and monoclinic modifications. Articles manufactured from ZrO_2 and tested at 2000°C with sharp temperature changes showed a high thermal stability. (R.V.J.)

3034 FORMATION OF HOT HYDROGEN OR DEUTERIUM ATOMS BY PHOTOLYSIS OF ORDINARY OR DEUTERATED WATER VAPOR. Cottin, Maurice; Vermeil, Catherine; Masanet, Jeannine (Ecole superieure de Physique et de Chimie, Paris). Compt. Rend., Ser. C, 263: 753-6(Sept. 19, 1966). (In French).

Two types of interception experiences of hydrogen atoms formed during the photolysis of water vapor by three radiations of different energy are described; the results are interpreted by the formation, in the primary step, of hydrogen atoms of kinetic energies varying with the energy of the incident photons. (tr-auth)

3035 HYDROGEN–DEUTERIUM EXCHANGE IN ORTHO- AND META-BARENES. Setkina, V. N.; Malakhova, I. G.; Stanko, V. I.; Klimova, A. I.; Zakharkin, L. I. (Inst. of Elementary Organic Compounds, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Khim., No. 9, 1678(1966). (In Russian).

Investigation of the kinetics of hydrogen exchange of o- and m-barenes in deuterated sulfuric and dichloroacetic acid solutions revealed that the rate of hydrogen exchange is 1.7×10^{-6} sec^{-1} and 2.0×10^{-6} sec^{-1}, respectively, at 50°C and a barene ($CHCl_2COOH:D_2SO_4$) molar ratio of 1;60;25. Isotopic equilibrium was calculated, on the basis of electric halogenation and alkylation, for four of the hydrogen atoms in o-barene and for two of the hydrogen atoms in m-barene assuming that the deuterium distribution coefficient is equal to a unit. It was found that isotopic exchange could be used to obtain the reactivity of barenes and their derivatives. (R.V.J.)

3036 DEUTERON MAGNETIC RESONANCE OF POLYCRYSTALLINE DEUTEROAMMONIA. Rabideau, Sherman W.; Waldstein, Peter (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 45: 4600-3(Dec. 15, 1966). (LA-DC-7808).

Deuterium magnetic resonance spectra of polycrystalline ND_3 were observed at 75, 159, and 185°K. The measured values of e^2qQ/h were 156 ± 7 kc/sec at 75°K, and 72.5 ± 0.9 kc/sec at 159 and 185°K. The decrease at the higher temperatures was attributed to rotational averaging. Single-crystal growth in the polycrystalline matrix was noted at the higher temperatures; it did not seriously interfere with the measurement of e^2qQ/h. Proton second-moment measurements were made on a polycrystalline sample of NH_3 at 75°K. The moment obtained was intermediate between the moments expected for the cases of fast and slow C_3 reorientation. The rotational-transition temperature has been estimated to be 72° ± 2°K. A lower limit of 1.75 kcal/mole for the reorientational activation energy was estimated. An anomalous absorption peak was recorded in the center of the ND_3 spectrum at 75°K. It may possibly be ascribed to a double-quantum transition. (auth)

3037 THE 4f AND 5f ELEMENTS. Haissinsky, M. (Laboratoire Curie, Paris); Joergensen, C. K. J. Chim. Phys., 63: 1135-8(Sept. 1966). (In French).

The differences in chemical and physical properties of elements characterized by the presence of a partially occupied 4f or 5f layer are discussed. The chemical characteristics of a given transition series begin at an atomic number Z, which is usually higher than that suggested by the spectroscopy. This shift is small in the 4f series and leads to the spectroscopic family of barides and the chemical family of lanthanides. It is more important in the 5f series and has as a consequence the formation of uranides, where the stability of the III valence increases with Z, and the maximal valence VI occurs in at least the first four members of the series, if not more. (auth)

3038 LATTICE CONSTANTS OF ALKALI–ACTINIDE(IV) FLUORIDES. Keller, C.; Schmutz, H. (Technische Hochschule, Karlsruhe, Ger. Gesellschaft fuer Kernforschung mbH, Karlsruhe, Ger.). Inorg. Nucl. Chem. Lett., 2: 355-8(Nov. 1966). (In German).

The compounds LiF · NpF_4, LiF · PuF_4, 7NaF · 6NpF_4, 7NaF 6PuF_4, 2NaF · NpF_4, 2NaF · PuF_4, 7KF · 6NpF_4, 7KF · 6PuF_4, 7RbF · 6NpF_4, and 7RbF · 6PuF_4 were prepared and their lattice constants determined. Data are presented in tables. (M.C.G.)

3039 THE ABSOLUTE STEREOCHEMISTRY OF H–D EXCHANGE IN BENZYL METHYL SULFOXIDE. THE ORIGIN OF THE KINETIC NONEQUIVALENCE OF THE METHYLENE PROTONS. Wolfe, Saul; Rauk, A. (Queen's Univ., Kingston, Ont.). Chem. Commun., No. 21, 778-80(Nov. 9, 1966).

The stereochemistry of hydrogen exchange in benzyl methyl sulfoxide was studied by NMR analysis in NaOD–D_2O medium. It was concluded that an electrostatic effect was responsible for the kinetic nonequivalence of the methylene protons and that an α-sulfinyl carbanion was generated preferentially in NaOD–D_2O by the abstraction of a proton, which was situated on the bisector of the oxygen-sulfur-lone pair angle. (D.H.M.)

3040 THE ABSORPTION SPECTRUM OF Cf^{+3}. Green, J. L.; Cunningham, B. B. (Univ. of California, Berkeley). Inorg. Nucl. Chem. Lett., 2: 365-71(Nov. 1966). (UCRL–17079).

The absorption spectrum of Cf^{+3} in a single crystal of anhydrous $CfCl_3$ and in polystyrene-sulfonic acid matrix (Dowex 50) was studied. Submicrogram quantities of ^{249}Cf were used and the techniques developed appear to be applicable to other actinide elements of limited availability. Using a hand spectroscope and microscope optics, the transmitted spectra obtained from a bead of Dowex 50 ion exchange resin saturated with $CfCl_3$ were observed. To obtain permanent records the spectra were photographed. (D.H.M.)

3041 APPLICATION OF RADIOISOTOPES IN THE RESEARCH OF PAINTS. Sokola, Karel (Research Inst. for Synthetic Resins and Lacquers, Pardubice, Czech.). Jad. Energ., 12: 222(June 1966). (In Czech).

A study of adhesion, desorption, and adsorption of the paints, permeability of films, aging during atmospheric exposure, and film formation is described. (JPRS)

3042 OSCILLATION-SPECTROSCOPICAL INVESTIGATIONS ON SOLID INORGANIC COMPOUNDS. PART 16. THE INFRARED SPECTRUM OF $Co_2(NH_3)_6C_2S_7$ AND $Co_2(ND_3)_6C_2S_7$. Mueller, Achim; Krebs, Bernt (Univ., Gottingen, Ger.). Z. Anorg. Allg. Chem., 345: 165-71(July 1966). (In German).

The infrared absorption frequencies of crystalline $Co_2(NH_3)_6C_2S_7$ and of its deuterated counterpart in the 4000 to 300 cm^{-1} range are presented and discussed. The spectrum-analysis results are discussed in terms of the structure of the salt, as yet not fully known, and in relation to the spectra of other amine complexes and noncomplex trithiocarbonates. Assignments of the bands were made. (JPRS)

3043 SOME SIX-CO-ORDINATE COMPLEXES OF URANIUM (VI). Day, J. P.; Venanzi, L. M. (Inorganic Chemistry Lab., Oxford). J. Chem. Soc. (A), No. 10, 1363-7(1966).

Twenty complexes of uranium(VI), of the type $[UO_2A_2B_2]^z$ (A, B = Cl, Br, I, Ph_3PO, or Et_3PO; the charge z = +2.0, or –2), were prepared and characterized. The interconversion of these compounds with uranium(VI) compounds is described. Infrared measurements show that the phosphine oxide and chloro-complexes have trans-configurations; the asymmetric stretching frequency of the uranyl group varies irregularly with A and B; and the symmetric stretch of the uranyl group is active in some cases, probably owing to hydrogen-bonding with $(R_3PH)^+$ cations. The paramagnetic susceptibility of the uranyl ion in these complexes ($86-147 \times 10^{-6}$ e.m.u./g.mol.) was independent of temperature. It was suggested that the previously reported tertiary phosphine complexes of uranium(IV) and uranium(VI), $[UX_4(R_3P)_2]$ and $[UO_2X_2(R_3P)_2]$ (R = Et, Pr^n, or Ph; X = Cl, Br, or I), are $[R_3PH]_2[UO_2X_4]$ and $[UO_2X_2(R_3PO)_2]$, respectively. (auth)

3044 METAL–β-DIKETONE COMPLEXES. PART III. METAL DERIVATIVES OF SOME PLATINUM–CARBON BONDED ACETYLACETONE COMPLEXES. Lewis, J.; Oldham, C. (The Univ., Manchester, Eng.). J. Chem. Soc.(A), No. 10, 1456-62 (1966).

The ions $[Pt(acac)_2X]^-$ (X = Cl, Br) reacted with a variety of bivalent metal salts to give the complexes $M[Pt(acac)_2X]_2$ (M^{2+} = Mn, Fe, Co, Ni, Cu, Zn, Cd, Pd, VO, or UO_2). The first seven members comprised an isomorphous series for both chloro- and bromo-complexes. The nmr spectra of the zinc and cadmium complexes indicated that the ligand groups $[Pt(acac)_2X]^-$ were maintained and still contain the platinum–carbon-bonded acetylacetone group. From the infrared spectra, the coordination of the halogeno-bisacetylacetonatoplatinum[II] ions occurs via the carbonyl oxygens of the carbon-bonded acetylacetone. The magnetic behavior over a temperature range and spectra of the nickel and cobalt salts indicated that the complexes are octahedral in stereochemistry. The ligand is considered to bond as a terdentally via two oxygens and a halogen atom. The complexes $M[Pt(acac)_3]_2$ (M^{2+} = Mn, Fe, Co, Cu, Cd, or Pd) were prepared and shown to involve bonding by some of the carbonyl of the platinum–carbon-bonded acetylacetone groups. A similar bonding pattern was found in the complex $Cd[Pt(acac)_2Cl_2]$. (auth)

3045 THE ADDITION OF HYDROGEN CHLORIDE AND HYDROBROMIC ACID TO 2,3-DIDEUTERIONORBORNENE. Stille, J. K.; Sonnenberg, Fred M.; Kinstle, Thomas H. (Iowa State Univ., Ames). J. Amer. Chem. Soc., 88: 4922-5(Nov. 5, 1966).

The synthesis of 2,3-dideuterionorbornene and the ionic addition of hydrogen halides to it were carried out. From the reaction of hydrogen chloride, about 50% of the product resulted from exo-cis addition without rearrangement. Of the portion of the product formed as a consequence of rearrangement, 38% came from a 6,2-hydride shift and 12% from a Wagner–Meerwein rearrangement. In the reaction with hydrobromic acid, the percentages were 40, 46, and 14, respectively. Dehydrohalogenation of the exo- and endo-2-halonorbornanes occurred nearly exclusively by abstraction of the exo-vicinal proton by base. The mechanistic interpretation of these results is discussed. (auth)

3046 THE ABSORPTION SPECTRUM OF RbD. VIBRATIONAL NUMBERING OF THE $A^1\Sigma$ STATE OF RbH. Bartky, Ian R. (National Bureau of Standards, Washington, D. C.). J. Mol. Spectros., 21: 1-3(Sept. 1966).

RbD was observed in absorption from 5200 to 5400 Å. Of the several bands observed in this region, two were analyzed in detail. The RbD spectrum correlates with the RbH spectrum only if the vibrational numbering of the $A^1\Sigma$ state of RbH is increased by 3. Revised molecular constants for RbH are given. (auth)

3047 THE ABSORPTION SPECTRUM OF CESIUM DEUTERIDE. THE $A^1\Sigma$ STATE OF CsH. Bartky, Ian R. (National Bureau of Standards, Washington, D. C.). J. Mol. Spectros., 21: 25-8(Sept. 1966).

An analysis of the visible absorption spectrum of CsD showed that the vibrational numbering of the $A^1\Sigma$ state of CsH must be increased by 3. From this and previous reassignments of the $A^1\Sigma$ states of KH and RbH, it is now possible to exhibit trends of the vibrational and rotational constants for the alkali metal hydrides. (auth)

3048 SELENIUM DIOXIDE OXIDATION OF 5 α-ANDROSTANE-3,17-DIONE. THE STEREOCHEMISTRY OF DEHYDROGENATION. Jerussi, Robert A.; Speyer, Daniel (New York Univ.). J. Org. Chem., 31: 3199-3203(Oct. 1966).

Oxidation of 5α-androstane-3,17-dione with selenium dioxide produced 5α-androst-1-ene-3,17-dione, androst-4-ene-3,17-dione, and androsta-1,4-diene-3,17-dione. Oxidation of 1α-deuterio-5α-androstane-3,17-dione to 5α-androst-1-ene-3,17-dione proceeded with 93% loss of deuterium and apparently with a small isotope effect. The androst-4-ene-3,17-dione also isolated from the isotope reaction contained almost all of the original deuterium, indicating that it was not formed by isomerization of the Δ^1 compound. (auth)

3049 DEUTERIUM ISOTOPE EFFECT IN OCTAHEDRAL SUBSTITUTIONS. PART II. THE BASIC HYDROLYSIS OF CHLOROHYDROXO-, CHLORONITRO-, AND DICHLORO-BIS (ETHYLENEDIAMINE)COBALT(III) CATIONS. Chan, S. C. (Univ. of Hong Kong). J. Chem. Soc. (A), No. 10, 1310-14(1966).

The combined effect produced by deuterations of solvent, nucleophile, and complex on the kinetics of basic hydrolysis of cis- and trans- $[Co\ en_2\ A\ Cl]^+$ cations in aqueous solutions was studied where A = OH, NO_2, and Cl and en represents ethylenediamine. The rates in the deuterated systems were lower than those in the corresponding protiated systems, and comparison with results obtained previously supports the idea that both solvolytic aquation and basic hydrolysis of octahedral cobalt(III) complexes are mechanistically similar, although the extent of bond-breaking in the transition state for the two types of reactions may be different. (auth)

3050 EFFECT OF INTERPARTICLE ADHESIVE FORCES ON FLUIDIZATION OF FINE PARTICLES. Baerns, Manfred (Argonne National Lab., Ill.). Ind. Eng. Chem., Fundament., 5: 508-16(Nov. 1966).

The feasibility of gaseous fluidization of particles in the size range of <50 μ was investigated. The ratio of the incipient fluidization velocity, calculated by a conventional relation without accounting for interparticle forces, to the incipient fluidization

velocity, determined by pressure drop and heat transfer measurements, was used as an index, Fl, describing the fluidizability of a particulate material. The results indicate that Fl is closely related to the interparticle adhesive force. The limitations of the feasibility of fluidization depend on the ratio of the weight of a particle to the sum of its weight and adhesive force; no fluidization could be obtained when this ratio was less than 10^{-3}. (auth)

3051 FLUIDIZATION TECHNIQUES IN NUCLEAR CHEMICAL TECHNOLOGY. Seidl, K. Jad. Energ., 12: 307-16(1966). (In Czech).

A review of the use of fluidization techniques in nuclear chemical technology is presented, discussing the accomplishments, advantages, and recent trends in fluidization techniques; it is based on a bibliography of fifty references, mostly from American sources. The examples of the application of the fluidization techniques are mostly from processes developed for the preparation of the uranium compounds basic to the operation of the nuclear industry, namely UO_3, UO_2, UF_4, and UF_6. Development of fluidization techniques in nuclear technology has reached a state of maturity not yet attained in other fields and the techniques developed should find application in other fields. Several difficulties in the use of fluidization techniques, for example, their dependence on the physical properties of the operating material, still await solutions. A step forward was the use of pulsed fluidization, which permits the use of materials that are difficult to fluidize in the conventional way. Brief descriptions and diagrams of some of the equipment used, yields obtained under varying conditions, and characteristics of the products obtained are included. (TTT)

3052 STUDY OF REDOX REACTIONS OF ACTINIDE ELEMENTS. PART I. KINETICS OF THE REACTION BETWEEN NEPTUNIUM(IV) AND NEPTUNIUM(VI) IN PERCHLORATE SOLUTIONS. Rykov, A. G.; Yakovlev, G. N. Radiokhimiya, 8: 20-6 (1966). (In Russian).

Kinetics of the reaction between Np(IV) and Np(VI) ions were studied in perchlorate solutions with an ionic strength of 2.0. Spectrophotometric determination of the concentrations of Np(IV), (V), and (VI) showed that the stoichiometric reaction is given by the equation: Np(IV) + Np(VI) → 2 Np(V). The reaction is first order with respect to both Np(IV) and Np(VI): $v = d[Np(IV)]/dt = k'[Np(IV)][Np(VI)]$. A study was made of the reaction rate as a function of acidity and temperature. A reaction mechanism is proposed, and corresponding reaction rate constants are given. The thermodynamic quantities characterizing the process of formation of both activated complexes were obtained, and values of their formal entropies were calculated. (JPRS)

3053 RADIOCOLLOIDS IN SORPTIVE SYSTEMS. IV. ROLE OF THE NEUTRAL ELECTROLYTE. Egorov, Yu. V.; Nikolaev, V. M.; Lyubimov, A. S. Radiokhimiya, 8: 8-14(1966). (In Russian).

The distribution of microcomponent radiocolloid was investigated in a sorptive system with a variable concentration of neutral electrolyte. It was found that if stepwise overcharging of neutral radiocolloid particles by electrolyte ions is assumed, the coefficient of gross distribution depends on the electrolyte composition according to a hyperbolic curve. Simplified variants of the isotherm are proposed and verified for the case of sorptions of ^{144}Ce by vermiculite from a sodium nitrate medium and sorption of $^{106}Ru(III)$ by activated manganese dioxide from a potassium chloride medium. It was found that one of the approximate formulas describing this system can also be derived from the assumption of a relationship of the heat effect of radiocolloid sorption with concentration of neutral electrolyte. (JPRS)

3054 PYRIDINE-2-ALDOXIME: A NEW COMPLEXING AGENT FOR THORIUM. Murthy, P. Radhakrishna; Rao, V. Ramachandra (Osmania Univ., Hyderabad, India). Curr. Sci. (India), 35: 461(Sept. 20, 1966).

Ultraviolet and infrared spectra of the thorium pyridine-2-aldoxime complex were studied. The four ring-stretching frequencies were located in the ligand and the chelate between 1650 and 1400 cm. (D.H.M.)

3055 THERMODYNAMIC STUDY OF THE VAPORIZATION BEHAVIOR OF THE SUBSTOICHIOMETRIC PLUTONIUM DIOXIDE PHASE. Ackermann, R. J. (Argonne National Lab., Ill.); Faircloth, R. L.; Rand, M. H. J. Phys. Chem., 70: 3698-3706(Nov. 1966).

A thermodynamic analysis of the vaporization of the substoichiometric plutonium dioxide phase [$\sim 1.6 \leq O/Pu \leq 2.0$] is presented. The results are based on measurements of the vapor pressure of known compositions in tungsten, rhenium, and tantalum effusion cells over the range of temperature from 1650 to 2100°K. The vapor pressures are interpretable in terms of $PuO_2(g)$, $PuO(g)$, and oxygen as the important vapor species; the partial pressure of the gaseous dioxide is relatively insensitive to the composition of the solid phase whereas the partial pressures of gaseous monoxide and oxygen (both atomic and molecular) show a marked dependence and become predominant near the lower and upper phase boundaries, respectively. Known thermodynamic data for the solid phase are combined with vapor pressure data to yield equations for the standard free energies of formation of gaseous dioxide and monoxide: $\Delta G_f^0[(PuO_2(g)] = -113{,}100 + 4.35T$ and $\Delta G_f^0[(PuO(g)] = -29{,}000 - 12.1T$. The congruently vaporizing composition is calculated to vary from O/Pu = 1.92 at 1600°K to 1.84 at 2400°K. (auth)

3056 INVESTIGATIONS OF OXIDATION-REDUCTION REACTIONS OF ACTINIDE ELEMENTS. III. KINETICS OF THE REACTION BETWEEN URANIUM(IV) AND BROMATE IONS IN PERCHLORATE SOLUTIONS. Rykov, A. G.; Vasil'ev, V. Ya.; Yakovlev, G. N. Radiokhimiya, 8: 33-42(1966). (In Russian).

The kinetics of oxidation-reduction reactions of ions of actinide elements with oxygen-containing anions was studied. The experiments on the determination of the stoichiometry of the reaction were conducted at 25°C in 2M $HClO_4$. The stoichiometric coefficient of the reaction remained approximately constant within the limits of 2.1 to 2.3 with a change in the ratio of initial reagent concentrations $[U(IV)]_0/[BrO_3^-]_0$ from 2.5 to 5.5. Evidently, the principal reaction is $2U^{4+} + BrO_3^- + 2H_2O = 2UO_2^{2+} + BrO^- + 4H^+$ accompanied by considerably slower oxidation of U(IV) by BrO^- ions. The reaction governing the rate of the overall process passed through two activated complexes formed under different equations. The reaction rate in the first route did not depend on concentration of hydrogen ions, and along the second—it was proportional to the square of the H^+ ion concentration. Thermodynamic values were found characterizing the reactions of formation of each activated complex. The formal entropy values of these complexes were calculated. (JPRS)

3057 INVESTIGATION OF COMPLEX FORMATION OF TRIVALENT ACTINIDES AND LANTHANIDES IN PHOSPHORIC ACID SOLUTIONS. Borisov, M. S.; Elesin, A. A.; Lebedev, I. A.; Filimonov, V. T.; Yakovlev, G. N. Radiokhimiya, 8: 42-7 (1966). (In Russian).

The complexation of trivalent americium, cerium, promethium, and yttrium in acidic phosphate solutions was studied. The investigation was conducted by an ion exchange method. For each element, several series of experiments were conducted at different pH values, which made it possible to establish the composition of the anion-addend, to determine the composition of complex ions, and to calculate their stability constants. It was established that at a phosphate concentration of from 3×10^{-4} to 0.1M and pH = 2 to 4, complex ions of the composition $MH_2PO_4^{2+}$ exist in solution. Concentration and thermodynamic constants of the stability of phosphate complex ions of americium, cerium, promethium, and yttrium were calculated. The stability of phosphate complexes of trivalent actinides and lanthanides exceeded the reliability of other complexes of these elements with single-charged inorganic addends and is comparable to the strength of weak organic complexes. (JPRS)

3058 IONIZATION OF THE COORDINATION COMPLEXES OF URANYL HALIDES WITH N,N-DIMETHYLFORMAMIDE IN ORGANIC SOLVENTS. Kaufmann, Gerard; Leroy, Maurice J. F.; Risse, Hugues (Univ., Strasbourg). Bull. Soc. Chim. France, No. 9, 2928-32(Sept. 1966). (In French).

Ionization of the complexes $UO_2X_2 \cdot 3DMF$ (X = Cl^-, Br^-; DMF = N,N-dimethylformamide) in various organic solvents was studied. By using a conductometric method, it was found that ionization takes place according to the reaction: $UO_2X_2 \rightleftharpoons UO_2X^+ + X^-$. The values of the equilibrium constant of the ionization reaction as well as the degree of dissociation and the parameter α of Bjerrum were determined at 25°C. For determining limited equivalent molecular conductivity, a calculation program was set up for the Bull γ AET calculator. (tr-auth)

3059 APPLICATION OF ISOTOPES IN PETROCHEMISTRY. APPLICATION OF ISOTOPES ON LUBRICATION MECHANISM AND ETHYLENE POLYMERIZATION. Ikeda, Sakuji (Tokyo Inst. of Tech.). Yukagaku, 14: 443-8(Aug. 1965). (In Japanese).

The lubricating action of sulfur was studied by the use of ^{35}S. The reaction mechanisms are, $Fe + S^* \xrightarrow{v_1} FeS^{**}$ and $FeS^{**} \xrightarrow{v_2}$ outside of the reaction system. The reaction constants for both the reactions, n: initial surface concentration of Fe on the surface, c: S concentration combined with Fe on the surface, l: concentration of S adsorbed on the surface that participates in the reaction, are expressed as $C = k_1 lm/(k_1 l + k_2)$. In the process of replacing FeS** with nonradioactive S, the decrease in the specific radioactivity of S is $-da/dt = \alpha v_2$, where α is the specific radioactivity of S** combined with Fe, and v_2 is equal to l/α

$[\alpha dc/dt + cd\alpha/dt]$. At the stationary state, $v_1 = v_2 = -\cos/\alpha \cdot d\alpha/dt$, and then $\ln(\alpha/\alpha_0) = -k_2 t$ is obtained. In the experiment, the contact surface area must be kept constant, and the absorption of β radiation and the "back diffraction" must be diminished. The polymerization mechanism of deuteroethylene was investigated. Cis- and trans-1,2-deuteroethylene were prepared and polymerized, and their polymer was investigated by the IR method. The IR spectra of cis-CHD = CHD differs from those of trans-CHD = CHD, and their fundamental frequencies for polymethylene chain are different from each other. (NSA of Japan)

3060 DEUTERIUM OXIDE SOLVENT ISOTOPE EFFECTS ON FAST REACTIONS OF SUBSTITUTED MALONIC ACIDS. Miles, Melvin H.; Eyring, Edward M.; Epstein, William W.; Anderson, Michael T. (Univ. of Utah, Salt Lake City). J. Phys. Chem., 70: 3490-3(Nov. 1966).

Acid dissociation constants were determined by potentiometric titrations, and rate constants were determined by the temperature-jump relaxation method in D_2O for a series of seven substituted malonic acids that were studied previously in water using the same techniques. The reaction of interest is $DA^- + OD^- \rightarrow A^{-2} + D_2O$ where DA^- represents the monoanion of a malonic acid in D_2O solvent. The slope of a Brønsted plot of the data indicated that in the transition state the proton was about equally bonded to the A^{-2} dianion and the OH^- ion. The reaction was slower in D_2O than in water, indicating a rate-determining proton transfer. These results are discussed in terms of an intramolecular hydrogen bond postulated to exist in such malonic acid monoanions. (auth)

3061 THE HYDROLYSIS OF CARBOXYLIC ANHYDRIDES. VII. ELECTROLYTE EFFECTS ON THE ACID HYDROLYSIS. Bunton, C. A.; Fendler, J. H. (Univ. of California, Santa Barbara. London Univ.). J. Org. Chem., 31: 3764-71(Nov. 1966).

Aqueous perchloric, sulfuric, and hydrochloric acids catalyze hydrolyses of trimethylacetic and camphoric anhydrides to different extents, but their specificities depend largely on their electrolyte effects on the activity coefficients of the anhydrides. The variation of rate of hydrolysis of benzoic anhydride in water with acidity is very complex, but if the ionic strength is maintained with added electrolyte the rate increases smoothly with increasing concentration of perchloric or hydrochloric acid. Provided that allowance is made for variations in the activity coefficients of camphoric and trimethylacetic anhydrides the rates of their acid hydrolyses are dependent in a simple way upon the protonating power of the acid and the water activity. Some studies were made of salt effects on spontaneous hydrolyses, and the deuterium isotope effect on it. (auth)

3062 ISOTOPIC EXCHANGE OF OXYGEN BETWEEN NICKEL OXIDE AND GASEOUS OXYGEN. Bailly, J. Cl.; Teichner, S. J. (CNRS, Lyon. Univ., Lyon). Bull. Soc. Chim. France, No. 9, 2722-9(Sept. 1966). (In French).

The lability of reticulate oxygen ions on the surface of NiO was observed from 200 to 270°C. The migration of adsorbed oxygen ions was distinguished from that of surface ions, the former probably constituting the slow stage of the exchange process. (tr-auth)

3063 STUDIES OF REDOX REACTIONS OF ACTINIDE ELEMENTS. PART II. KINETICS OF THE REACTION BETWEEN NEPTUNIUM(IV) AND NEPTUNIUM(VI) IN NITRATE SOLUTIONS. Rykov, A. G.; Yakovlev, G. N. Radiokhimiya, 8: 27-32(1966). (In Russian).

The effect of complexing of Np(IV) and Np(VI) with nitrate ions on the kinetics of the stoichiometric reaction $Np(IV) + Np(VI) \rightarrow 2\,Np$ was investigated at an ionic strength of 2.0. The reaction is first order with respect to both Np(IV) and Np(VI): $-d[Np(IV)]/dt = \frac{1}{2}\,d[Np(V)]/dt = k'[Np(IV)][Np(VI)]$. In the presence of nitrate ions, the reaction passes through two activated complexes, which then decompose via independent paths. The main path of the reaction involves the formation of an active complex whose composition includes only one NO_3^- ion. The thermodynamic quantities (ΔH^*, ΔG^*, ΔS^*, S^*) characterizing the formation of the nitrate activated complex were calculated. (JPRS)

3064 INFRARED-SPECTROSCOPIC INVESTIGATIONS ON THE SO_3-H_2O AND SO_3-D_2O LIQUID SYSTEMS. PART 3. THE OSCILLATION SPECTRA OF LIQUID SULFUR TRIOXIDE. Stopperka, K. (Technical Univ., Dresden). Z. Anorg. Allg. Chem., 345: 277-89(July 1966). (In German).

Means for obtaining the infrared spectra of anhydrous liquid sulfur trioxide are described, and the spectra are presented and discussed. The characteristics of the components, SO_3 and S_3O_9, are described and the Raman spectra obtained were compared to those presented by other researchers in the literature. (29 references) (JPRS)

3065 CHELATE CHEMISTRY. V. METAL CHELATES BASED ON TROPOLONE AND ITS DERIVATIVES. Muetterties, E. L.; Roesky, H.; Wright, C. M. (E. I. du Pont de Nemours and Co., Wilmington, Del.). J. Amer. Chem. Soc., 88: 4856-61 (Nov. 5, 1966).

Rare earth tris chelates based on the γ-isopropyltropolone anion are associated and presumably contain seven- or eight-coordinate metal ions. The degree of association drops significantly in going from the large lanthanide cations to the smaller ions such as lutetium(III). Some of the smaller ions, such as erbium, tend to separate from aqueous solutions as monohydrated tris chelates. Monomolecular formulations were established for the solution state of $(chel)_2SnCl_2$, $(chel)_3SnCl$, and $(chel)_3NbO$ with the γ-isopropyltropolone anion ligand. Bis(isopropyltropolono)nickel(II) (paramagnetic) is not very soluble in nonbasic solvents and must be significantly associated. Chelate chemistry based on the monothio analog of tropolone is similar to that of the tropolone ion. Eight-coordinate lead and thorium(IV) chelates from thiotropone were readily obtained. Attempts to prepare ten-coordinate pentakis chelates like the known $Th(tropolonate)_5^-$ anion were unsuccessful with the thiotropone anion. Further distinctions between tropolone and thiotropone chemistry arise in nickel(II) chelates where the thiotropone derivative is diamagnetic and square-planar. Tracer studies of basic hydrolyses of thiotropone cationic chelates identified ligand attack by hydroxyl ion as a significant, but not dominating, hydrolysis course. (auth)

3066 STRUCTURE OF $K_4[Th(SO_4)_4(H_2O)_2]$ CRYSTALS. Arutyunyan, E. G.; Porai-Koshits, M. A.; Molodkin, A. K. (Kurnakov Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Zh. Strukt. Khim., 7: 733-7(Sept.-Oct. 1966). (In Russian).

X-ray analysis of $K_4Th(SO_4)_4 \cdot 2H_2O$ system revealed a chain structure of the compound. The thorium coordination polyhedron is nine pointed in the shape of a trigonal prism with three centered faces. (R.V.J.)

3067 REACTION KINETICS OF POWDERED URANIUM AND DEUTEROAMMONIA. Alire, R. M.; McCrary, J. H. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 45: 3958-65 (Dec. 1, 1966).

A rate law for the nitridation of pyrophoric uranium with deuteroammonia was established for the entire course of the reaction. The rate of reaction between powdered uranium and deuteroammonia was determined to be a linear function of the initial Brunauer, Emmett, and Teller (BET) surface area and the fraction of unreacted uranium. Sintering of powdered uranium to a stable surface area was found to be a prerequisite to reproducible experiments. The fractional composition of the products UN and $U_2N_3-UN_2$ solid solution was found to be constant for the entire course of the reaction. An interpretation of the results was done in terms of a diffusion mechanism involving diffusion of uranium ions to the surface as the rate-determining step. The temperature coefficient in the range 265 to 385°C was described by the Arrhenius law and the activation energy was measured to be 25 ± 3 kcal/mole of uranium reacted. (auth)

3068 MASS SPECTROMETRY OF IONS IN GLOW DISCHARGES: APPLICATION TO H_2-D_2 EXCHANGE REACTIONS. Dawson, P. H.; Tickner, A. W. (National Research Council, Ottawa). J. Chem. Phys., 45: 4330-6(Dec. 1, 1966).

The negative glow of the dc glow discharge was used to study H_2-D_2 exchange by an ionic chain reaction. The ions present were observed directly by mass spectrometry. The chain carrier was H_3^+ and the chain length about 15 at 0.3 torr. The inhibition by added rare gases was examined and detailed comparisons are made with radiolysis experiments. Qualitatively the agreement is excellent. Several possible inhibition mechanisms are considered. (auth)

3069 THERMAL DIFFUSION IN SOME BINARY MIXTURES OF THE HYDROGEN ISOTOPES. Grew, K. E.; Humphreys, A. E. (Univ. of Exeter, Devon, Eng.). J. Chem. Phys., 45: 4267-73 (Dec. 1, 1966).

Thermal-diffusion measurements were made by the two-bulb method for the mixtures H_2-HD, H_2-HT, H_2-D_2, $HD-D_2$, and D_2-DT. With one bulb always at 293°K, the temperature of the other was varied between 14 and 195°K and the separation factor was determined. For H_2-HT, the upper limit was 770°K. Values of the thermal-diffusion factor α_T in the temperature range from 200 to 300°K, where it is nearly independent of temperature, are given for all the mixtures, and compared with measurements by other workers. The values show large discrepancies. Below 200°K, α_T decreases with decreasing temperature as expected theoretically and eventually becomes negative at very low temperatures. The absolute magnitude of α_T for any mixture in the

region where it is negative is very much greater than that predicted unless quantal considerations are invoked. (auth)

3070 ISOTOPE EFFECTS ON METASTABLE TRANSITIONS: C_3H_8 AND C_3D_8. Lifshitz, Chava; Shapiro, Moshe (Hebrew Univ. of Jerusalem). J. Chem. Phys., 45: 4242-8 (Dec. 1, 1966).

Metastable transitions were studied in the mass spectra of propane and perdeuterated propane in a sector mass spectrometer. The relative abundances of the various metastable ions at 70 eV were determined. One parent-ion metastable transition was studied carefully: the methane loss at m/e = 17.8 in C_3H_8 and at m/e = 19.7 in C_3D_8. This transition shows a pronounced isotope effect on the yield. Appearance potentials were determined for the ions involved by the RPD method and for the metastables themselves by conventional techniques. Reaction rate constants for the metastable transitions were determined by using a pulsed ion source: $k = 3.2 \times 10^4$ sec^{-1} for C_3H_8 and $k = 8.3 \times 10^4$ sec^{-1} for C_3D_8, at 13 eV. The results are discussed in terms of the quasiequilibrium theory of mass spectra. (auth)

3071 SIMPLIFIED PROCEDURE FOR THE THEORETICAL CALCULATION OF ISOTOPE EFFECTS INVOLVING LARGE MOLECULES. Stern, Marvin J. (Yeshiva Univ., New York. Brookhaven National Lab., Upton, N. Y.); Wolfsberg, Max. Contract AT(30-2)-Gen-16. J. Chem. Phys., 45: 4105-24(Dec. 1, 1966). (BNL-10160).

It is demonstrated that statistical-mechanical calculations of isotope effects on rates and on equilibria can be simplified, without introducing significant error, by omitting large portions of the molecules involved. Parts of the molecules can be "cut off" more than two bonds removed from the position(s) of isotopic substitution at which force-constant changes occur between reactant and transition state in a rate process or between reactant and product in an equilibrium process. Sometimes more extreme cutoff is possible. The force-constant and geometry changes at the isotopic position(s) must be the same in the cutoff and complete calculations. The success of the cutoff procedure focuses attention on the fact that experiments that determine isotope effects in the room-temperature region and above can directly yield information regarding only changes occurring in the neighborhood of the isotopic position(s). (auth)

3072 ISOTOPIC THERMAL-DIFFUSION FACTOR FOR KRYPTON. Paul, R.; Watson, W. W. (Yale Univ., New Haven). J. Chem. Phys., 45: 4132-4(Dec. 1, 1966).

The isotopic thermal-diffusion factor α_0 for krypton was determined over a temperature range of 242 to 643°K. An artificial mixture of krypton isotopes containing about 14% ^{82}Kr and 10% ^{86}Kr was utilized in conjunction with a 10-tube swing separator; α_0 was obtained from the concentration changes in these two isotopes only. A least-squares fitting procedure yields potential parameters $\alpha = 16.1 \pm 0.6$, and $\epsilon/k = 244 \pm 13$°K for the exponential-six potential model. Further least-squares fitting with viscosity data gives $r_m = 3.88 \pm 0.02$ Å. Satisfactory agreements were obtained, between experimental data and values calculated according to the present potential, for coefficients of diffusion and thermal conductivity. The calculated values for second virial coefficient from this potential, however, showed rather poor agreement with experimental values. (auth)

3073 VAPOUR AND CRYSTAL SPECTRA IN POLARIZED LIGHT OF PYRIMIDINE-d_0 AND PYRIMIDINE-d_4. Sbrana, G.; Adembri, G.; Califano, S. (Univ., Florence). Spectrochim. Acta, 22: 1831-42(Nov. 1966).

The infrared spectra of pyrimidine-d_0 and -d_4 were measured between 4000 and 300 cm^{-1} in gas, liquid, and solid phases. Since the analysis of the rotational band envelopes alone was not sufficient for a definite assignment, useful information was gained from the interpretation of the crystal spectra in polarized light of both isotopic species. A new vibrational assignment is presented which differs from that given previously by Lord et al., for the six fundamentals ν_{6a}, ν_{19a}, ν_{6b}, ν_{18b}, ν_{19b}, ν_4. The experimental evidence for the new assignment is discussed in detail. (auth)

3074 INTEGRATED ABSORPTION INTENSITY OF THE C=O STRETCHING BANDS OF NORMAL AND ^{15}N-BARBITURIC ACID. Pinchas, S. (Weizmann Inst. of Science, Rehovoth, Israel). Spectrochim. Acta, 22: 1889-95(Nov. 1966).

The integrated absorption intensity of the C=O stretching bands of 99% ^{15}N-barbituric acid dissolved in dimethylsulfoxide was measured in comparison with that of the C=O bands of normal barbituric acid and was found to be practically the same in both cases. The origin of the different C=O bands of barbituric acid is discussed on basis of the observed ^{15}N-isotope shifts of these bands. The assignment of other bands observed for the solution of this acid is suggested. (auth)

3075 FORCE CONSTANTS OF HYDRAZOIC ACID AND METHYL AZIDE. Thompson, W. T.; Fletcher, W. H. (Univ. of Tennessee, Knoxville). Spectrochim. Acta, 22: 1907-21(Nov. 1966).

A valence force field was derived for hydrazoic acid using the frequencies and centrifugal distortion constants in an iterative computation. The Urey-Bradley force field is inadequate if a fit of the distortion constants is required. The force constants of HN_3 were combined with those of a "standard methyl group" to predict the frequencies of methyl azide. A re-examination of the spectra of CH_3N_3 and CD_3N_3 plus the calculations have led to revised assignments of the fundamentals. (auth)

3076 LOW TEMPERATURE OXIDATION. Jost, W. (ed.). New York, Gordon and Breach, 1965. 423p. (AGARDograph-86).

Information on the following topics is included: kinetic basis of oxidation processes; oxidation of hydrogen, carbon monoxide, carbon disulfide, hydrogen sulfide, and hydrocarbons; combustion of methane; oxidation by oxides of nitrogen and ozone; "knock" in spark-ignition engines; mode of action of "anti-knocks"; and the pyrolysis of organic compounds. Author and subject indexes are included. (J.G.B.)

3077 REDKOZEMEL'NYE ELEMENTY I IKH MESTO V PERIODICHESKOI SISTEME. (The Rare Earth Elements and their Place in the Periodic System). Trifonov, D. N. Moscow, Izdatel'stvo Nauka, 1966. 192p.

A brief review is given of the history of rare earth placement in the periodic table and the concepts associated with assigning the positions. Chemical and physical bases and theoretical analyses are given of the periodical scheme and the general problem of the f-family in the periodic table are discussed. (R.V.J.)

3078 PYROHYDROLYSIS OF CARBIDE-TYPE NUCLEAR FUEL. Flanary, J. R.; Goode, J. H.; Wall, G. C. (to U. S. Atomic Energy Commission). U. S. Patent 3,278,278. Oct. 11, 1966.

A method was developed for hydrolyzing a carbide of a metal selected from uranium, thorium, and plutonium. The carbide is contacted with an essentially oxygen-free steam atmosphere at a temperature in the range from 700 to 1150°C until the selected metal carbide is converted to a carbon-free oxide powder. (AEC)

3079 PROCESS FOR PREPARING OXIDE GEL MICROSPHERES FROM SOLS. Clinton, S. D.; Haas, P. A.; Hirth, L. J.; Kleinsteuber, A. T. (to U. S. Atomic Energy Commission). U. S. Patent 3,290,122. Dec. 6, 1966.

Inorganic microspheres of a predetermined size may be formed from a stable hydrous sol by concurrently introducing a fine stream of the hydrous sol and a surrounding stream of an organic liquid capable of extracting water from the sol into a zone for droplet forming and congealing. By controlling the flow rates of the two streams microspheres with predetermined diameters in the range of 50 to 1,000 microns may be formed. (AEC)

3080 METHOD OF PREPARING PLUTONIUM MONONITRIDE. Leary, Joseph A.; Nance, Robert L. (to U. S. Atomic Energy Commission). U. S. Patent 3,279,898. Oct. 18, 1966.

A method for preparing nonpyrophoric plutonium mononitride consists of heating powdered plutonium metal or plutonium hydride to a temperature not exceeding 600°C in a nitrogen atmosphere and within a closed vessel, heating the resulting product to 800°C, removing any gaseous products evolved through a vacuum system, and reacting the outgassed powder with additional nitrogen at a temperature of about 800°C. (AEC)

3081 PREPARATION OF BINARY COMPOUNDS OF URANIUM AND THORIUM. Hansen, W. N. (to U. S. Atomic Energy Commission). U. S. Patent 3,272,601. Sept. 13, 1966.

A method for converting a metal of the actinide series into a binary compound selected from the class consisting of carbides, nitrides, and oxides is described. The metal is dissolved in mercury to form an actinide metal quasi-amalgam reaction product, which is distilled with a preselected gas from the class consisting of hydrocarbon gases, ammonia, and oxygen. Thus the metal is separated from the mercury and the corresponding carbide, nitride, or oxide is obtained. (AEC)

3082 METHOD OF SELECTIVELY REDUCING PLUTONIUM VALUES. Rainey, R. H. (to U. S. Atomic Energy Commission). U. S. Patent 3,276,850. Oct. 4, 1966.

Plutonium is reduced from the tetravalent to the trivalent oxidation state in the presence of hexavalent uranium using hydrogen in the presence of a hydrogenation catalyst as the reducing agent. (AEC)

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Refer also to abstracts 3468 and 3556.

3083 (AEET-256) ANNEALING BEHAVIOR OF LOW TEMPERATURE NEUTRON-IRRADIATED TRIS-ACETYLACETONE COBALT(III) IN ELECTRON-ACCEPTING (OXYGEN) AND INERT (NITROGEN) AMBIENTS. Sarup, S.; Nath, Amar (Atomic Energy Establishment, Trombay (India). Chemistry Div.). 1966. 23p. Dep. mn.

A detailed comparative study of the kinetics of annealing of neutron-irradiated 2,4-pentanedione cobalt(III) in the presence of oxygen (air) and in its absence (in nitrogen) was carried out. The characteristic features of the annealing behavior were interpreted on the basis of the 'variable depth electron donors–exchange' model. (auth)

3084 (BNL–10730) PROGRESS REPORT ON THE ETHYLENE POLYMERIZATION FLOW EXPERIMENT AT BROOKHAVEN NATIONAL LABORATORY. Kukacka, L. E.; Steinberg, M. (Brookhaven National Lab., Upton, N. Y.). Oct. 1966. Contract AT-30-2-GEN-16. 20p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A small-scale ethylene polymerization flow experiment was studied to confirm the kinetic data obtained in capsule experiments and to produce sufficient quantities of polymer (up to approximately 1 lb/batch). The experimental procedure consisted of pressurizing the system with the control valve closed, irradiating the gas for a known period of time, removing the ^{60}Co source, and then discharging the polymer through the control valve. Three apparent differences between the capsule and flow experiments were found: ethylene gas purity; holdup in the discharge line and vessel that could cause recirculation of product in the vessel and excessive radiation doses to part of the polymer resulting in crosslinking; and the product discharge line acting as a tubular reactor to produce a material with a broad molecular weight distribution with a very high molecular weight fraction. (P.C.H.)

3085 (TID–23401) SPUR COALESCENCE IN RADIATION CHEMISTRY. Faw, Richard E. (Kansas Engineering Experiment Station, Manhattan). Dec. 2, 1963. Contract AT(11-1)-751. 37p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Kans. State Univ. Eng. Exp. Sta., Spec. Rep. No. 44.

The radiation chemistry of liquids is discussed in terms of the diffusion kinetics of chemical reactions in a linear chain of free radical spurs. The diffusion hypothesis of Samuel and Magee was adopted in order to allow analytical solutions of the diffusion kinetics equations. Solutions are presented for pairs of spurs or infinite chains of spurs and are compared to previously reported solutions for isolated spurs. The effect of radiation quality on free radical yield is discussed in some detail and a method for including this effect in the numerical calculations of free radical yields is presented. Problems arising from fluctuations in spur size and separation are considered. (auth)

3086 (Y–1562) CURING PLASTICS WITH GAMMA RADIATION. Harper, W. L.; Napier, B. Jr. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Oct. 17, 1966. Contract W-7405-eng-26. 25p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Several monomeric systems were polymerized with gamma radiation. Shear and compressive strengths were determined and correlated with the radiation dose. (auth)

3087 EFFECT OF POLYCYCLIC AROMATIC ADDITIVES ON THE RADIOLYSIS YIELDS FROM METHANOL. Ekstrom, A.; Garnett, J. L. (Univ. of New South Wales, Sydney). Chem. Commun., No. 22, 832-3(Nov. 23, 1966).

During an investigation into the effects of polycyclic additives on the yields of radiolysis products from methanol, evidence was obtained for the extensive participation of free-radical scavenging by these additives. The chemical fate of the polycyclic additives was investigated. The addition of polycyclic hydrocarbons decreased the yields of hydrogen and ethylene glycol from methanol, and extensive decomposition of the hydrocarbons occurred. Evidence of a two-step production in the hydrogen yield from methanol was obtained, but was not observed in the ethylene glycol yield, indicating that the scavenging of the solvated electron resulted in a decrease in the hydrogen, but not of the ethylene, yield. Results suggest that the decomposition of the additives was due predominantly to radical scavenging by the additive and by implication, that free-radical scavenging contributes significantly to the "protection effects" observed in these systems. (D.H.M.)

3088 HYDROGEN ISOTOPE EFFECTS ARISING FROM THE REACTION OF HYDRATED ELECTRONS. Ohno, Shin-ichi (Japan Atomic Energy Research Inst., Tokyo). Bull. Chem. Soc. Japan, 39: 2560(Nov. 1966).

The isotope effect in the formation of hydrogen atoms arising from the reaction between e^-_{aq} and proton donors during the radiolysis of water was studied. In a H_2O-D_2O mixture containing 1M methanol, the photochemically produced electron from 10^{-3}M $K_4[Fe(CN)_6]^4$ reacted with added solute, SH; the hydrogen atoms produced (H and D) reacted with CH_3OH to yield H_2 and HD, the observed value of H_2/HD gave directly the hydrogen atom ratio (H/D). An Arrhenius plot of the log of the rate of bond breaking (k_H/k_D) vs 1/T gave a value of 1340 ± 20 cal/mol for the difference in the activation energy of O–H and O–D bond fission in the hydronium ion. The activation energy for the reaction e^-_{aq} with D_3O^+ is predicted to be about 4.5 kcal/mol. (D.H.M.)

3089 THE REACTIONS OF t-$C_4H_9^+$ IN THE RADIOLYSIS OF NEOPENTANE IN THE GAS PHASE. Miyazaki, Tetsuo; Shida, Shoji (Tokyo Inst. of Tech.). Bull. Chem. Soc. Japan, 39: 2344-6(Nov. 1966).

The yields and reactions of t-$C_4H_9^+$ produced in the radiolysis of neopentane in the gas phase were studied by the use of ammonia. The yields of iso-C_4H_8 increased sharply with the addition of a small amount of ammonia in the radiolysis of neopentane and showed a constant value on the further addition of ammonia (more than 10 mol %). Since this increase is due to the reaction t-$C_4H_9^+$ + NH_3 → iso-C_4H_8 + NH_4^+, G(t-$C_4H_9^+$) = 1.76 was obtained by assuming the increment of iso-C_4H_8 to be equal to the yield of t-$C_4H_9^+$. This value is consistent with the value expected from the mass spectrum of neopentane. The ammonia method is a very effective general method for studying the reactions of ions. It is applicable to the study of ions under high pressures, ions that can not be studied by a mass spectrometer, and less reactive ions. (auth)

3090 RADIOCHEMISTRY OF OXYCHLORIDE COMPOUNDS. IV. TRANSFORMATIONS OF PERCHLORATE ION IN NEUTRAL AQUEOUS SOLUTIONS. Bugaenko, L. T.; Wang, Wen-sin; Belevskii, V. N. (Moscow State Univ.). Zh. Fiz. Khim., 40: 2094-2100(Sept. 1966). (In Russian).

The radiolysis of 1 to 8M aqueous solutions of $NaClO_4$ was investigated from –196 to 100°C. In liquid solutions the reduction of perchlorate ions led to chlorate ions and chlorine, and in frozen solutions the formations of chlorine dioxide and chlorite and hypochlorite ions was observed. Perchlorate ions in liquid solutions did not interact with the radiolysis products of water, and in frozen solutions reactions between perchlorate ions and thermal electrons took place. This reaction was most effective at –78°C. The ratio of the constant of the reaction velocity of thermal electrons with H_3O^+ and perchlorate ions was equal to 3.2 at –196°C. A mechanism for the radiation-chemical transformation of perchlorate ion in frozen solutions was proposed. (tr-auth)

3091 INVESTIGATION OF THE MECHANISM OF THE RADIOLYSIS OF AMMONIA, ADSORBED ON ZEOLITE, BY ELECTRON PARAMAGNETIC RESONANCE. Sorokin, Yu. A., Kotov, A. G.; Pshezhetskii, S. Ya. (Karpov Scientific-Research Inst. of Physics and Chemistry, USSR). Zh. Fiz. Khim., 40: 2277-82(Sept. 1966). (In Russian).

The formation of paramagnetic centers during gamma irradiation of zeolite 5A (calcium form) + NH_3 was investigated by the EPR method. The formation of NH_2 radicals, adsorbed on the zeolite surface, was investigated. Comparison of the data obtained with the data for 4A zeolite + NH_3 led to the conclusion that the mechanism for the transmission of the irradiation energy, absorbed by the zeolite, to the adsorbed ammonia was connected to the presence of sodium ions in the zeolite lattice. (tr-auth)

3092 CONDUCTIVITY OF HEXANE AFTER ACTION OF γ RADIATION AND ITS SIGNIFICANCE FOR DOSIMETRY. Jahns, A.; Jacobi, W. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Z. Naturforsch., 21a: 1400-10(Sept. 1966). (In German).

The influence of primary and secondary recombination on the γ induced conductivity of liquid n-hexane was studied experimentally and theoretically. Conductivity measurements were made with a parallel-plate ionization chamber, varying the electrical field, the electrode distance, and the dose rate. The primary recombination can be explained with a theory developed by Onsager for the recombination of single ion pairs in dense gases, whereas Jaffe's theory of column ionization is not applicable. Independent of the ion mobilities, for hexane in absence of an electric field a G-value of 0.13 ± 0.01 for the ion pairs escaping primary recombination was obtained; this corresponded to a mean escape probability of 3% and a mean effective initial distance of the ions in an ion pair of 80 mμ. The applicability of liquid-filled ionization chambers for dosimetry is discussed. (auth)

3093 PROBLEM OF THE ORIGIN OF THE IRRADIATION EFFECTS ON THE RATE OF THERMAL DECOMPOSITION OF AMMONIUM PERCHLORATE. Komarov, V. F.; Boldyrev, V. V.; Zhuravlev, V. K.; Ivanov, G. V. Kinet. Kataliz, 7: 788-91(Sept.-Oct. 1966). (In Russian).

The reaction rates of thermal disintegration were studied with pure ammonium perchlorates, perchlorates containing chlorate ions, and ammonium perchlorates irradiated by 200-keV x rays. It was found that impurities and irradiation caused a more rapid thermal disintegration reaction. However, the effects of impurities and x irradiation were not identical. The data obtained were used for determining the mechanism of radiation effects on the subsequent disintegration of NH_4ClO_4. (tr-auth)

3094 CATALYTIC ACTIVITY OF γ-IRRADIATED AQUEOUS SOLUTIONS OF COMPLEX Co(III) SALTS. Shagisultanova, G. A.; Neokladnova, L. N. Kinet. Kataliz, 7: 894-6(Sept.-Oct. 1966). (In Russian).

The catalytic activity of irradiated solutions of geometrically isomeric dichlorodiethylenediaminecobalt chloride was studied. The effects of γ radiation on the cis-trans-isomers were also investigated, and their ability for initiating disintegration of hydrogen peroxide was analyzed. (tr-auth)

3095 THE EFFECT OF IONIZING RADIATION ON THE CHEMICAL ACTIVITY OF ALUMINA. Steele, L. R. (Squibb Inst. for Medical Research, New Brunswick, N. J.); Cooper, W. H. J. Catalysis, 6: 147-51(Aug. 1966).

These studies demonstrated that ionizing radiation enhances the activity of γ-Al_2O_3 as a catalyst for H_2-D_2 exchange. Measurements of catalytic activity were made during irradiation. Adsorption alumina was irradiated in a 5-Mw swimming-pool type nuclear reactor at a γ dose rate of 10^7 Rad/hr. The contribution by fast neutrons was less than 1% of the total dose. Slugs of 10% D_2–10% H_2–80% He were injected into the process carrier stream and activity measurements were taken. After passing over the catalyst, the slug was trapped and analyzed by gas chromatography to determine the ratio of HD to D_2. A definite enhancement of the activity by radiation was observed. The advantage of in situ measurements was demonstrated; activity decayed rapidly towards its initial value once it was removed from the radiation field. The effect of temperature on the radioinduced activity was examined. It decreased with increasing temperature. At 150°C and 10^7 Rad/hr, the change was only a factor of 4 or 5, whereas at 50°C, the activity increased by almost 3 orders of magnitude. Hydrogen exchange appears to occur without any significant activation energy on the sites produced during irradiation. (BBB)

3096 REACTIONS OF CROSSLINKING IN POLYSILOXANE CHAINS OF DIFFERENT STRUCTURE BY ACTION OF γ RADIATION. Poddubnyi, I. Ya.; Averyanov, S. V. Vysokomol. Soedin., 8: 1549-55(Sept. 1966). (In Russian).

The effects of the side-group type at the Si-atom and the presence and nature of hetero units in the main chain on the γ radiation vulcanization efficiency of both filled and unfilled siloxane rubbers were investigated. The relation between structure and heat resistance of polysiloxane was determined. A method for further increasing the heat resistance of polysiloxane rubber now can be recommended. Possible reaction mechanisms are discussed. (auth)

3097 SOLID STATE CHLORINATION OF POLYPROPYLENE BY IONIZING IRRADIATION. Dzhagatspanyan, R. V.; Korolev, B. M.; Zetkin, V. I.; Filippov, M. T. Vysokomol. Soedin., 8: 1745-53(Oct. 1966). (In Russian).

In the solid state chlorination of polypropylene caused by γ irradiation there is a chain reaction in the volume of polymer ($G \simeq 10^5$ chlorine atoms/100 eV). At the first stage of the reaction only the amorphous phase of polymer is chlorinated. The reaction rate is proportional to chlorine pressure and polymer concentration. Chain termination is close to linear. An intradiffusional reaction mechanism is proposed. (auth)

3098 RADIOLYSIS OF AMMONIA ADSORBED ON ZEOLITES. Sorokin, Yu. A.; Zakharov, V. F.; Pshezhetskii, S. Ya.; Kotov, A. G. (Karpov Inst. of Physical Chemistry, USSR). Zh. Fiz. Khim., 40: 2468-73(Oct. 1966). (In Russian).

A higher selectivity and level of ammonia conversion into hydrazine was observed during irradiation of adsorbed ammonia as compared to that with liquid and solid-phase ammonia. The hydrazine yield corresponds to the yield of HN_2 radicals formed with irradiated specimen heating at liquid nitrogen temperature. Radiolytic hydrazine formed with ammonia saturation of the zeolite surface; this was confirmed by the N_2H_3 radical signal appearance in the EPR spectrum. The radiation dose for producing the signal depends on the temperature. The formation of the radical occurs during hydrazine molecule disintegration forming, by recombination, NH_2 radicals. (R.V.J.)

3099 MASS-SPECTROMETRIC STUDY OF IONS AT NEAR-ATMOSPHERIC PRESSURE. III. THE ALPHA RADIOLYSIS OF METHANE. Haynes, R. M.; Kebarle, P. (Univ. of Alberta, Edmonton). J. Chem. Phys., 45: 3899-3904(Dec. 1, 1966).

The ion-molecule reactions occurring in the alpha radiolysis of methane were studied in a mass spectrometer under near-conventional radiolysis conditions (1 to 160 torr pressure and a few milliseconds ion reaction time). Comparison of the observed high intensities of CH_5^+ and $C_2H_5^+$ at 1 torr with spectra obtained previously with conventional microsecond reaction times showed that the reactions of CH_5^+ and $C_2H_5^+$ with methane are very slow ($k < 10^{-15}$ cc molecule^{-1} · sec^{-1}). At higher pressures $C_nH_{2n-1}^+$, $C_nH_{2n+1}^+$, and $C_nH_{2n+2}^+$ are observed with $n \leq 6$. The addition of trace concentrations of normal and deuterated hydrocarbons helps to elucidate some of the reactions involved. The ions observed in the presence of traces of deuterated alkanes present a complete confirmation of reactions proposed earlier by Ausloos whose work was based on neutral product studies in α-radiolyzed methane and deuterated alkanes. It is shown that impurities at concentrations of 1 ppM affect the course of the ionic reactions in the radiolysis of methane at near-atmospheric pressures. The origin of the ions observed in "pure" methane at pressures above 10 torr is therefore uncertain. These ions are probably largely due to impurities. (auth)

3100 X- AND γ-RAY-INDUCED RADIOLYTIC ISOMERIZATION OF SOLUTIONS OF STILBENE. Fischer, Ernst (Weizmann Inst. of Science, Rehovoth, Israel); Lehmann, H. P.; Stein, Gabriel. J. Chem. Phys., 45: 3905-13(Dec. 1, 1966). (NYO-3242-16).

X- and γ-irradiation of benzene solutions of cis- or trans-stilbene causes interconversion towards a stationary cis → trans mixture. The yield of interconversion is smaller for cis → trans than for trans → cis. Both yields increase with stilbene concentration up to a limiting G (trans → cis) of about 2.5 at 0.1M, which corresponds to G (excited stilbene) of about 5. At low stilbene concentrations the yield is lowered by oxygen and by anthracene and enhanced by naphthalene, triphenylene, phenanthrene, and diphenyl. Diacetyl and p-terphenyl preferentially enhance the trans → cis conversion. The results are explained on the basis of primary excitation of solvent benzene, which forms excited stilbene by energy transfer, as in photosensitized isomerization. Direct excitation and possibly charge recombination may account for the primary solvent excitation. Enhancement by additives is due to energy transfer from excited benzene to form eventually triplet additive, which, owing to its much longer lifetime, has a greatly improved chance to transfer its energy to stilbene, at lower concentrations of the latter. A detailed study was made of the change of G (isomerization) with the concentration of stilbene (5×10^{-5} to 10^{-1}M) and of naphthalene (0 to 7.8M). For 0.1M trans-stilbene, G (formation of excited stilbene) is about 5 in benzene and about 6 in molten naphthalene. Cyclohexene, used as a specific scavenger of triplet benzene, retards the isomerization by about one-third, while nitrous oxide, used as an electron scavenger, has no effect. Isomerization yields in toluene are higher than in benzene, while those in methylcyclohexane are much lower. Addition of naphthalene strongly increases the isomerization yields in both solvents, just as in benzene. No significant temperature dependence was found. X rays at 200 keV have only about 60% of the efficiency of ^{60}Co gamma rays. (auth)

3101 DESCRIPTION OF A TECHNIQUE FOR IRRADIATION OF GASES BY ELECTRONS AT 10- TO 100-keV. Hellemans, Louis; Claes, Paul; Huyskens, Pierre (Univ., Louvain, Belg.). J. Chim. Phys., 63: 1164-70(Sept. 1966). (In French).

A technique for irradiation by electrons at 10 to 100 keV is described. An irradiation method previously used for liquids was applied to gases. The absorbed dose can be determined by a physical method controlled by chemical dosimetries. There was good agreement between the dosimeters used. (auth)

3102 GAMMA RADIOLYSIS OF POTASSIUM FERRO- AND FERRI-CYANIDE SOLUTIONS. II. DEGASSED ACID SOLUTIONS. III. ALKALINE SOLUTIONS. Haissinsky, Moise; Koulkes, Anne-Marie; Masri, Edouard (Laboratoire Curie, Paris). J. Chim. Phys., 63: 1129-34(Sept. 1966). (In French).

The principal product of γ radiolysis of degassed acid solutions of $K_4Fe(CN)_6$ was ferropentacyanide with G = 0.8. Irradiation of ferricyanide gave ferrohexacyanide with G = 1.1 and ferropentacyanide with $G \simeq 0.25$. By secondary reactions the solute was eventually decomposed by steps to Fe^{3+}. In 0.1N NaOH solution, the ferricyanide disappeared with G = 2.3, ferrohexacyanide was formed with G = 2 and ferropentacyanide with G = 0.3. The results are compared with those of other authors and discussed. (auth)

3103 ENERGY DEPENDENCE OF CROSS SECTIONS FOR HOT TRITIUM REACTIONS WITH HYDROGEN AND DEUTERIUM MOLECULES. Karplus, M.; Porter, R. N.; Sharma, R. D. (Watson Scientific Computing Lab., New York, Columbia Univ., New York). J. Chem. Phys., 45: 3871-3(Nov. 15, 1966).

Analyses of experimental data for hot-atom reactions are usu-

ally based upon the assumption that the reaction cross section (S_r) is nonzero over a finite hot-atom energy $E_1 \leq E \leq E_2$. Values of E_2 are reported for $T + H_2 \rightarrow HT + H$ and $T + D_2 \rightarrow DT + D$. Detailed calculations of the reaction and dissociation cross sections in the high energy range are also given. A modified London-Eyring-Polanyi-Sato method was used for determining the potential energy function, and the quasiclassical trajectory treatment was used for evaluating the cross sections. (J.G.B.)

3104 RADIATION CHEMISTRY OF LIQUID SULFUR DIOXIDE. II. RADIATION-INDUCED OXIDATION-REDUCTION REACTIONS IN LIQUID SULFUR DIOXIDE SOLUTIONS OF SULFUR TRIOXIDE AND POTASSIUM IODIDE. Rothschild, Walter G. (Ford Motor Co., Dearborn, Mich.). J. Chem. Phys., 45: 3594-8(Nov. 15, 1966).

Irradiation by ^{60}Co gamma rays of dilute solutions of sulfur trioxide in anhydrous, air-free liquid sulfur dioxide confirmed that molecular oxygen is formed by attack of radicals on sulfur trioxide, most likely via $O + SO_3 \rightarrow SO_2 + O_2$, and that no measurably significant amount of O_2 is formed by radical recombination $O + O \rightarrow O_2$ in the spurs. Irradiation of air-free anhydrous solutions of potassium iodide in liquid sulfur dioxide yielded iodine and potassium bisulfate $K_2S_2O_7$ at constant rates and to high percents of conversion of iodide to iodine. The data are discussed in terms of electron-transfer reactions from the charge-transfer complex iodide anion-sulfur dioxide to the oxygen atom. The possibility of reactions of iodide ion with ionic species which have been suggested to arise in liquid sulfur dioxide during radiolysis is considered briefly. The difference between the radiation chemistry of liquid sulfur dioxide on one hand and those of water and liquid ammonia on the other is believed to be a consequence of the radical scavenging properties of liquid sulfur dioxide. (auth)

3105 ISOTOPE EFFECTS IN THE 77°K γ IRRADIATION OF ICE. Siegel, Seymour; Rennick, Robert (Aerospace Corp., El Segundo, Calif.). Contract AF 04(695)-669. J. Chem. Phys., 45: 3712-20(Nov. 15, 1966).

The radiation yields of H_2, D_2, and HD obtained by the 77°K γ irradiation of solute-free mixed H_2O and D_2O ice mixtures were determined by use of mass spectroscopy. The total gas yields were determined, too, both by use of a calibrated mass spectrometer and by manometric methods. Significant isotope effects were observed over a wide range of the isotopic compositions studied, (i.e., the deuterium content varied from ~0.016% to 99.8%). The separation factor $\alpha_G = [(H/D)_{gas}/(H/D)_{ice}]$ varied from about 70 for the high D content ice to about 1.0 for natural isotopic abundance ice. At $(H/D)_{ice} = 1.0$, α_G is 1.7. Values of α_G were obtained for 99.80% D_2O over a temperature range of 4.2° to 196°K. The separation factor was found to be inversely proportional to temperature. The results were compared with those in a previously published EPR study of stabilized H and D atoms after irradiation at 4.2°K. The observed effects are discussed briefly in terms of several models of selective energy absorption. (auth)

3106 SOLVENT EFFECTS UPON RADIATION-INDUCED GRAFT COPOLYMERIZATION OF STYRENE ONTO LIGNIN. Koshijima, Tetsuo; Muraki, Einosuke (Government Industrial Research Inst., Osaka). Nippon Mokuzai Gakkaishi, 12: 139-44 (June 1966). (In Japanese).

Gamma radioinduced (^{60}Co) graft copolymerization of styrene onto hydrochloric acid-treated pine (Pinus densiflora) lignin, previously methylated with diazomethane, was carried out with addition of methanol, ethanol, 2-propanol, 1-butanol, n-hexane, and benzene to the lignin–styrene (1:10) system, in order to get homogeneous and highly grafted copolymer. It was found that methanol markedly accelerates the grafting but benzene does not. Two percent of methanol with styrene monomers gave rise to a maximum grafting ratio of 430%, which diminished rapidly with increasing concentrations of methanol. With both n-hexane and benzene, greater amounts of styrene monomers polymerized to polystyrene homopolymer in comparison with results of polystyrene being grafted onto lignin molecules. Alternatively, 40% of styrene monomers grafted onto lignin and only 17% was converted to its homopolymer by addition of 2% methanol. The facts that the optimum methanol concentration is very low (2%), the degree of the solvent effects depends upon the G values, and styrene monomers graft onto molecules selectively by addition of methanol, suggest that the effects of methanol upon lignin–styrene graft copolymerization occur by radicals subsequently produced by radiolysis of added methanol. Either both or one of the two radicals H· and $\dot{C}H_2OH$, which predominate among the radicals arising from methanol, probably act to increase active centers in lignin molecules. Experiments on the solvent effects of methanol, ethanol, 2-propanol, and 1-butanol support this deduction. Initial graft copolymerization velocities of the lignin–styrene–methanol system were proportional to the square root of the dose rate used. This graft copolymerization was inhibited completely by addition of hydroquinone. These findings indicate that graft copolymerization progresses by radical reaction. When an ether–dioxane–water mixture was used, instead of ether as solvent in diazomethane-methylation of lignin, grafting rates of resultant graft copolymers increased appreciably in lignin–styrene–benzene and lignin–styrene systems, independently of the methoxyl contents of original lignins. (BBB)

3107 OXIDATION OF LIGNIN-STYRENE GRAFT POLYMER. Koshijima, Tetsuo (Government Industrial Research Inst., Osaka). Nippon Mokuzai Gakkaishi, 12: 144-50(June 1966).

Styrene was used as a monomer in the graft copolymerization of lignin from pine (Pinus densiflora) under the effect of ^{60}Co γ radiation. The resultant grafted product seemed to be homogeneous but the grafting ratio is only 40% of the theoretical at the dose of 10^7 R. When 2% methanol was added to the styrene–lignin system, and grafting performed in the same way, the grafting ratio increased to 430%, i.e., ten times. The effect of methanol upon this grafting is ascribed to the radicals produced from methanol, which act to increase the active species in lignin molecules. The radioinduced graft copolymerization in the lignin–styrene–methanol system thus appears to progress according to a radical mechanism. The lignin–styrene graft polymer was insoluble in all organic solvents examined, and gave a transparent, pale yellow, brittle thin plate by rolling and pressing at 130 to 145°C. To verify that the grafted products of the lignin–styrene–methanol system are formed by chemical bonding of lignin molecules with polystyrene, the products were subjected to oxidation with chlorine dioxide or nitrobenzene. Removal of lignin contained in the grafted products by chlorine dioxide oxidation was extremely difficult; 24% of the total lignin remained in the grafted products even after oxidation by chlorine dioxide 11 times. The results of nitrobenzene-induced oxidation of the grafted products of lignin–styrene showed that grafting arose actually in the lignin–polystyrene system. Guaiacyl residues participating in the graft copolymerization corresponded to 64% of those in the original lignin, to which at least 5 to 10 units of styrene per one guaiacyl residue linked, in the grafting range of 100 to 400%. (BBB)

3108 MODIFICATION OF CELLULOSE FINE STRUCTURE: EFFECT OF THERMAL AND ELECTRON IRRADIATION PRETREATMENTS. Millett, Merrill A.; Goedken, Virgil L. (Forest Products Lab., Madison, Wis.). Tappi, 48: 367-71(June 1965).

An evaluation was made of two pretreatments for modifying cellulose fine structure to accomplish a favorable change in the kinetics of the saccharification process: thermal treatment over the temperature range of 180 to 260°C; and a series of combined thermal and electron irradiation treatments at economic dose levels. Optimum conditions for thermal treatment occurred at ~200°C where a maximum increase in sugar yield of about 27% and a maximum increase in rate of dilute acid hydrolysis of about 35% were obtained with a 32-hr heating period. Irradiation with 8-MeV electrons at 10^6 R followed by heat treatment at 200°C for increasing time periods of 0 to 16 hr raised the maximum sugar yield from 22.5 to 28.5%, an increase of 30%. Heat treatment at 200°C followed by irradiation at 10^6 R was less effective, maximum sugar yield increasing from 22.5 to 27.0%. Results obtained from the 30-day delayed hydrolysis were similar to those obtained from immediate hydrolysis, indicating no postirradiation effects. Both types of treatment increased the rate of cellulose hydrolysis by a factor of about 1.5 and increased the overall sugar yield by a factor of about 1.3. However it was concluded that, while the hydrolytic activity of cellulose can be enhanced by thermal and mild electron irradiation pretreatments, this enhancement is not sufficient to be of potential commercial significance. (TCO)

3109 RADIOCHEMICAL YIELDS OF GRAFT POLYMERIZATION REACTIONS OF CELLULOSE. Arthur, Jett C. Jr.; Blouin, Florine A. (Southern Regional Research Lab., New Orleans). J. Appl. Polymer Sci., 8: 2813-24(1964).

The ^{60}Co γ-radioinduced grafting of vinyl, styrene, and acrylonitrile monomers onto high molecular weight cellulose from cotton was studied. The preparation of radioinduced graft polymers of cotton cellulose, which retained the fibrous nature and high molecular weight of the cellulose, depended primarily on the radiochemical yields of cellulose reactions and of graft polymerization reactions. Yields of the initial major molecular changes in cellulosic polymer indicated that, in the case of scission of the molecule and carboxyl group formation, chain reactions were not initiated by radiation; however, in the case of carbonyl group formation chain reactions were initiated but quickly terminated. Generally, experimental procedures used in graft polymerization reactions were: simultaneous irradiation reaction, that is, application of monomers or solutions of monomers to cellulose or

chemically modified celluloses, then irradiation; and postirradiation reactions, that is, irradiation of cellulose or chemically modified celluloses, then, after removal from the field of radiation, contacting the irradiated cellulose with monomer. Some of the most important factors influencing the radiochemical yields of graft polymerization reactions of styrene and acrylonitrile onto cellulose were: concentration of monomer in treating solution, solvent, ratio of monomer solution to cellulose, prior chemical modification of cellulose, and absence of oxygen, particularly in postirradiation reactions. (BBB)

3110 STUDY BY MASS SPECTROMETRY OF THE DECOMPOSITION OF AMMONIA BY IONIZING RADIATION IN A WIDE-RANGE RADIOLYSIS SOURCE. Melton, Charles E. (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 45: 4414-24(Dec. 15, 1966). (ORNL-P-2422).

A wide-range radiolysis source, which can be used to approximate an ideal experimental study of a chemical reaction induced by ionization, was designed and constructed for a study of the decomposition of ammonia. The source consists of three separate compartments in series, each with a separate electron beam which can be independently controlled over a wide range of intensity and energy. The pressure in the source can be varied over a range of 10^{-9} to 10 torr and decreases progressively from compartment to compartment. Reactions can be followed in time starting from about 10^{-14} sec after irradiation up to the time for the formation of final stable products. Each compartment has a distinct function and is used to observe reactions which occur at different times after irradiation. Irradiation of NH_3 with 100-eV electrons at a pressure of 1 torr in the wide-range radiolysis source produced 74.9% H_2, 24.9% N_2, and 0.2% N_2H_4 as reaction products with G values of 8.8, 2.9, and 0.03, respectively. Positive-ion-molecule reactions produced 54% of the H_2, 63% of the N_2, and 20% of the N_2H_4. All of the products appeared at a threshold energy of about 4 eV corresponding to the energy necessary to produce H^- and NH_2^- from NH_3 by electrons. The abundance of the products increased sharply at about 10 eV corresponding to the ionization potential of NH_3. The primary products of irradiation were 58.8% positive ions, 40.8% free radicals and neutral species, and 0.4% negative ions. Cross sections for the production of each of the species by 100-eV electrons and appearance potentials of the negative ions are reported. The total cross sections observed were: positive ions, 2×10^{-16}; negative ions, 1.4×10^{-18}; and free radicals, 1.4×10^{-16} cm^2/molecule. In addition to the free radicals produced by dissociation of NH_3, the secondary radicals NH_4, N_2H_2, N_2H_3, and N_2H_5 were observed. Appearance potentials were measured and in some cases calculated (by an energy-calibrated molecular-orbital scheme) for the free radicals and the following values in electron volts were obtained: experimental, H (13.8), N (14.6), NH (12.8), NH_2 (11.7), N_2H_2 (9.9), N_2H_3 (7.6), and N_2H_4 (8.8); theoretical: NH_2 (10.5), N_2H_2 (10.1), and N_2H_3 (7.8). The most abundant positive and negative ions observed at 1 torr pressure were NH_4^+, 83% and NH_2^-, 51%. Rate constants and cross sections are given for the positive-ion-molecule reactions; the negative-ion spectrum is reported for a pressure of 1 torr. NH_2, H, and NH_4^+ were found to be the most important transient species in the reaction mechanism and that essentially all of the primary ions formed react with NH_3 to produce NH_4^+ and either H or NH_2. (P.C.H.)

3111 CHEMISTRY OF POSITIVE IONS. VI. POSITIVE-ION CHEMISTRY IN SOLID METHANE. Davis, Donald R. (Univ. of California, Los Angeles); Libby, W. F.; Meinschein, W. G. J. Chem. Phys., 45: 4481-92(Dec. 15, 1966).

The polymerization of solid metnane at 77°K by γ rays was studied at two dose rates in the dose range 4 to 150 MRAD, corresponding to 0.04 to 1.4% conversion. The polymer contains an average of 20 carbon atoms per molecule and its empirical formula is $C_{20}H_{40}$, independent of the dose. The yield is 0.32 methane molecules converted to polymer per 100 eV absorbed and any induction dose must be less than 1 MRAD (0.01% conversion). A detailed characterization of the polymer based on physical and spectroscopic studies is reported. Products up to heptane are identified. Preliminary studies of solid ethane and propane afforded polymer with lower yields and fewer numbers of monomer units than the methane polymer. From an analysis of the dose and dose-rate dependence of the polymerization of solid methane, it was concluded that only two types of mechanism are possible. The most useful mechanism is one in which a carbonium ion is transformed directly into a heavy hydrocarbon ion. This process would require about 6 eV of excitation energy. The other possible mechanism requires an efficient energy-transfer process leading to repetitive polymer-building and polymer-degrading reactions. (auth)

3112 NATURE OF THE OPTICAL ABSORPTION SPECTRA OF ELECTRONS TRAPPED IN IRRADIATED FROZEN AQUEOUS SOLUTIONS. Ershov, B. G.; Pikaev, A. K. (Inst. of Physical Chemistry, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Khim., No. 9, 1637-9(1966). (In Russian).

The optical absorption spectra of trapped electrons in irradiated vitreous solutions of NaOH, KOH, $NaClO_4$ in H_2O and D_2O were measured at −196°C. At this temperature and at room temperature the spectra of the electrons depend on the charge transfer to the solvent. (tr-auth)

3113 MECHANISM OF FORMALDEHYDE FORMATION DURING THE RADIOLYSIS OF DEAERATED METHANOL. Pikaev, A. K.; Sibirskaya, G. K. (Inst. of Physical Chemistry, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Khim., No. 9, 1639-41(1966). (In Russian).

The formaldehyde yield during the radiolysis of deaerated methanol is almost constant during increase of the dose output from 2.5×10^{14} to 3×10^{23} ev/ml sec, whereas the ethylene glycol yield is decreased three times. The formaldehyde basically is formed in "spurs" because of the decomposition and reactions of ionizing excited methanol molecules. (tr-auth)

3114 RADIATION-INDUCED CHAIN REACTION IN SOLUTIONS OF TETRACHLOROETHYLENE IN N-PENTANE. Rajbenbach, L. A.; Horowitz, A. (Soreq Nuclear Research Centre, Yavne, Israel). Chem. Commun., No. 21, 769-71(Nov. 9, 1966).

The products from gamma radiolysis of solutions of tetrachloroethylene in n-pentane was studied. The liquid products were determined chromatographically and identified by mass-spectrometric and infrared analysis. Hydrogen chloride was analyzed coulometrically. The yields of chloropentanes and trichloroethylene increased only slightly with growing concentration of tetrachloroethylene. The formation of pentyltrichloroethylene and to a lesser extent HCl increased almost linearly with the concentrations of the solute. (D.H.M.)

3115 IMPROVED ORGANIC SCINTILLATORS IN 2-ETHYL NAPHTHALENE. Christophorou, L. G.; Carter, J. G. (Oak Ridge National Lab., Tenn.). Nature, 212: 816-18(Nov. 19, 1966).

The omission intensities of organic scintillators using 2-ethylnaphthalene (2-EN) as solvent are compared with two popular liquid scintillators, p-terphenyl in toluene and p-terphenyl with POPOP (2,2-phenylenebis-[5-phenyloxazole]) in toluene. The scintillators in 2-EN gave more light for a given exposure dose than the commonly used scintillators. The scintillating system found most efficient was DPA (diphenylanthracene) in 2-EN and DBM (di-n-butyl mercury) mixture. It appears that the use of solvents that form excimers results in an increased efficiency of energy transfer from solvent to solute. The solvent excimer acts as a secondary solute, which is less readily quenched by impurities than the solvent excited monomer. (D.H.M.)

3116 EFFECT OF DENSITY ON THE RADIOLYSIS OF PROPYLENE. Trachtman, M. (Univ. of Pennsylvania, Philadelphia. Frankford Arsenal, Philadelphia). J. Phys. Chem., 70: 3382-8(Nov. 1966).

The radiolysis of propylene was studied at various temperatures both below and above the critical temperature as a function of density. The yields of both H_2 and CH_4 decreased with increasing density at all temperatures. The most striking feature of the data is the apparent constancy of the yield of H_2 and CH_4 in the two-phase region. There appeared to be a density-independent region above the critical temperature. Propylene was irradiated in the presence of O_2 and the results show that in the gas phase the yields of H_2 and CH_4 were sharply decreased. In the two-phase region the inhibitory effect of O_2 is markedly decreased for both H_2 and CH_4. Mixtures of propylene and propylene-d_6 at various densities, were irradiated in the presence and absence of scavenger. Higher molecular weight products were measured as a function of density, and like H_2 and CH_4 were found to decrease with increasing density in the density range 0.01 to 0.07 g/cc. (auth)

3117 CHEMICAL DOSIMETRY BY MEANS OF THE CCl_4–DITHIZONE SYSTEM. Patko, J.; Szentirmay, Zs.; Dezsi, Z. (Lajos Kossuth Univ., Debrecen, Hungary). Acta Phys. Chim. Debrecina, 11: 27-31(1965).

The radiolytic decomposition of CCl_4-diphenylthiocarbazone (dithizone) was investigated. It was established that using a diphenilthiocarbazone concentration of 10^{-4} M/l the changes in optical density measured at 610 nm are the measure of the absorbed dose. Using this diphenilthiocarbazone concentration doses from 5 to 600 R can be measured by means of a spectrophotometer. A possible explanation of the observed effect is given and some other characteristics of the dosimeter system are discussed. (auth)

3118 ON THE QUESTION OF THE EFFECTS OF O ATOMS IN THE ELUCIDATION OF RADIATION-CHEMICAL RADICAL PROCESSES BY HIGH FREQUENCY DISCHARGES. Froben, Friedrich Wilhelm; Mohrmann, Hasso (Univ., Gottingen, Ger.). Z. Phys. Chem. (Frankfurt), 51: 101-3(Oct. 1966). (In German).

The action of ionizing radiation was simulated by high-frequency discharges and the reactions of oxygen atoms formed in discharges in oxygen and water vapor were studied. An oxidizing effect from the oxygen atoms was observed. (M.C.G.)

3119 MECHANISM OF THE RADIATION-CHEMICAL HYDROXYLATION OF 4-NITROPHENOL IN AQUEOUS SOLUTIONS. Graesslin, D.; Merger, F.; Schulte-Frohlinde, D.; Volkert, O. (Kernforschungszentrum, Karlsruhe, Ger.). Z. Phys. Chem. (Frankfurt), 51: 84-94(Oct. 1966). (In German).

From the gamma radiolysis of 4-nitrophenol in aqueous solutions, 2-hydroxy-4-nitrophenol, 4-aminophenol, hydrogen, and hydrogen peroxide are formed. The G-values of the products were found to be independent of the dose, the concentration, and the pH. From the results it was concluded that the hydroxylation occurs in 2 steps. The first is the addition of an OH radical to the 4-nitrophenol selectively in the 2-position during formation of a cyclohexadienyl radical. In the second step the cyclohexadienyl radical is dehydrated to 2-hydroxy-4-nitrophenol. (M.C.G.)

3120 ENERGY TRANSFER IN THE PHOTO- AND RADIATION CHEMICAL cis-trans ISOMERIZATION OF OCTENE-2 IN BENZENE. Golub, Morton A.; Stephens, Curtis L. (Stanford Research Inst., Menlo Park, Calif.). J. Phys. Chem., 70: 3576-81(Nov. 1966).

The photo- and radiation-induced cis–trans isomerization of octene-2 in benzene was studied in the presence and absence of various carbonyl or aromatic additives, which can function as donors of triplet excitation energy. A number of additives with lowest triplet energy in the range from 74 to 50 kcal/mole were effective in sensitizing the photoisomerization; the ultimate cis–trans ratio was dependent on the sensitizer energy. These same sensitizers, with one exception, and others of lower triplet energy all produced a decrease in G value for the radiation-chemical isomerization compared to that for octene-2 in pure benzene, presumably as a result of competitive quenching of the benzene triplet by both additive and olefin molecules. (auth)

3121 VAPOR-PHASE POLYMERIZATION OF ETHYLENE BY HIGH-ENERGY RADIATION. Sawayanagi, Shoichi; Hinaji, Chuhei (Japan Atomic Energy Research Inst., Tokyo). Genshiryoku Kogyo, 12: No. 2, 49-54(Feb. 1966). (In Japanese).

A description is given of vapor-phase polymerization of ethylene by high-energy radiation. The polymerization facilities in the authors' laboratory, with 300,000 Ci of ^{60}Co as the radiation source, are outlined; a flow diagram of their polymerization apparatus is also given. Some of the properties of radiation-polymerized polyethylene are: molecular weight $\overline{M}_v$, 1.5 to 30×10^4; density d^{25}, 0.925 to 0.945; melting point, 112 to 125°C; degree of branching CH_3/1000 C, 0 to 10; degree of crystallization, 65 to 85%; melt indices MI and HMI, 105 and 2.2; and $\overline{M}_w/\overline{M}_n$ value, 1.5 to 4. (NSA of Japan)

3122 RADIATION-CHEMICAL CARBONYLATION OF METHANOL. Getoff, N.; Seitner, D. (Oesterreichische Studiengesellschaft fuer Atomenergie, GmbH, Vienna). Z. Phys. Chem. (Frankfurt), 51: 27-34(Oct. 1966). (In German).

The radioinduced carbonylation of methanol in aqueous solutions saturated with carbon monoxide was studied in respect to its dependence on radiation dose (up to 5×10^{19} eV/ml), the pH value (–0.3 to 12), and the concentration of methanol (10^{-5} to 25M CH_3OH). The initial G-value (G_i) of the glycolic aldehyde formed in the carbonylation of 10^{-2}M CH_3OH was 0.92 at pH 2.8 and 0.70 at pH 5.4. The yield of glycolic aldehyde showed a maximum at pH 0.5 (G = 1.75 using 10^{-2}M CH_3OH at 2.58×10^{-19} eV/ml). An unusually shaped curve was obtained in studying the dependence of the glycolic aldehyde yield on the concentration of CH_3OH at pH 5.4 and a dose of 2.58×10^{19} eV/ml. The yield rose rapidly within the range from 10^{-5} to 10^{-2}M CH_3OH, passed a maximum at 2×10^{-2}M CH_3OH (G = 0.51) and a minimum at 3M CH_3OH (G = 0.14). Then it rose again and reached its highest value in the irradiation of pure (25M) methanol saturated with CO (G = 0.78). A reaction mechanism was suggested to explain the experimental results. (auth)

3123 SYNTHESIS OF HIGHLY ORIENTED POLYTHIOMETHYLENE DIRECTLY BY THE RADIATION POLYMERIZATION OF CRYSTALLINE TRITHIANE. Lando, J. B.; Stannett, V. (Research Triangle Inst., Durham, N. C.). J. Polym. Sci., Pt. B: 2: 375-8(1964).

The gamma-induced polymerization of crystalline trithiane was found to yield highly oriented polythiomethylene. Two finely ground samples of trithiane were irradiated at room temperature. One tube was opened and the contents were found to dissolve in hot chloroform. The second tube was placed at 195°C for 18.5 hrs. Extraction of the contents with boiling chloroform left a 20% residue of light-brown powder, which did not sublime in a vacuum under temperature and pressure conditions at which trithiane readily sublimes. A sample of the insoluble residue was found to melt in air at 245 to 260°C under a polarizing microscope, the same melting point reported for polythiomethylene prepared from molten trithiane with cationic catalysts. A single crystal of trithiane was heated 165 hrs at 180°C. An x-ray photograph of the crystal indicated no change in the trithiane crystal. The crystal was then gamma irradiated and heated at 180°C for 143 hrs. An x-ray photograph showed five markedly oriented powder rings not attributable to trithiane. The d spacings of these rings were the same as those previously reported for polythiomethylene. (D.H.M.)

3124 ULTRAVIOLET AND ELECTRON RADIATION INDUCED ADDITION TO OLEFINS OF FORMAMIDE. Gush, D. P.; Marans, N. S.; Wessells, F.; Addy, W. D.; Olfky, S. J. (Washington Research Center, Clarksville, Md.). J. Org. Chem., 31: 3829-31 (Nov. 1966).

Both the ultraviolet- and peroxide-induced addition of formamide to olefins was reported in the literature. For the ultraviolet-induced reaction, no quantum efficiencies were reported; for the peroxide-induced reaction, the efficiency was low. The quantum efficiency of the ultraviolet-induced reaction was determined and the electron-induced reaction was studied. Both the quantum yield for the ultraviolet-induced addition and the G value for the electron-induced reaction were found to be low. (auth)

3125 THE CHEMISTRY OF ALLENE. II. THE KINETICS OF FREE-RADICAL ADDITION OF HYDROGEN BROMIDE. Heiba, El-Ahmadi I.; Haag, Werner O. (Mobil Oil Corp., Princeton, N. J.). J. Org. Chem., 31: 3814-17(Nov. 1966).

The kinetics of radiation-initiated free-radical addition of HBr to allene at –78°C was investigated and a mechanism for the reaction proposed. Bromine atom adds both to the terminal and the central carbon of allene with a ratio of the corresponding rate constants $k_1/k_2 = 2.0$, i.e., the addition occurs statistically. Reversibility of Br-addition at C_1 and nonreversibility of addition at C_2 of allene accounts for the effects of the reaction conditions on the ratio of terminal and central adducts, [T]/[C]. At constant temperature, [T]/[C] is independent of allene concentration, but is uniquely dependent on the HBr concentration. (auth)

3126 STUDY OF THE MICROSTRUCTURE OF POLYISOPRENES PREPARED BY RADIOCHEMICAL INITIATION. Hinschberger, Andre; Marchal, Jean (Centre de Recherches sur les Macromolecules, Strasbourg). Compt. Rend., Ser. C, 263: 667-9(Sept. 5, 1966). (In French).

It was found that the microstructure of polyisoprenes prepared by radiochemical initiation varies with the dose output. This variation is a direct proof of the coexistence of two radiochemical polymerization mechanisms. One is radical and the other is cationic. (tr-auth)

3127 RECOMBINATION OF RADICALS AND FORMATION OF GLYCOLS DURING RADIOLYSIS OF BINARY ALCOHOL SOLUTIONS. Roginskii, V. A.; Kotov, A. G.; Pshezhetskii, S. Ya. (Karpov Inst. of Physics and Chemistry, Moscow). Teor. Eksp. Khim., 2: 479-85(July-Aug. 1966). (In Russian).

The EPR method was used for determining the recombination of stabilized radicals in frozen aliphatic alcohol solutions. Recombinations of similar or different radicals took place with the same regularity. Analysis of recombination products of alcohol radicals, glycols, in the ethanol–methanol system confirmed this conclusion. Certain differences were observed in the dependence of glycol yield on the composition of the solution during increases in the temperature of radiolysis. They were the result of more frequent reactions between atomic hydrogen and alcohol molecules caused by higher temperatures. Equations derived by kinetic analysis of the recombination products are in agreement with the experiment. (R.V.J.)

3128 AN ELECTRON SPIN RESONANCE STUDY OF THE γ RADIOLYSIS AND THE PHOTOLYSIS OF FROZEN AMMONIA–WATER SYSTEMS. Al-Naimy, B. S.; Moorthy, P. N.; Weiss, J. J. (Univ., Newcastle-upon-Tyne, Eng.). J. Phys. Chem., 70: 3654-60(Nov. 1966).

The radical formed on γ irradiation of frozen ammonia–water systems at 77°K was identified as the NH_2 radical. The yields of NH_2 radicals were studied as a function of the ammonia concentration in these systems. Possible explanations were offered for the dependence of the yields $G(NH_2)$ on the ammonia concentration and for the different shapes of the ESR signal of the NH_2 radical in the different ammonia–water matrices. The effect of electron acceptors on the NH_2 radical yield in the γ radiolysis of frozen am-

nia–water systems was studied. Somewhat similar observations were made in the ultraviolet photolysis of these systems at 77°K. (auth)

3129 COMBINED EFFECTS OF DOSE RATE AND TEMPERATURE IN THE RADIOLYSIS OF LIQUID CHLOROFORM. APPLICATION OF HOMOGENEOUS KINETICS TO THE RADIOLYTIC SYSTEM. Abramson, Fred P.; Firestone, Richard F. (Ohio State Univ., Columbus). J. Phys. Chem., 70: 3596-3605(Nov. 1966).

The effects of dose rate and temperature on the 100-eV yields of the major radiolysis products of pure air-free liquid $CHCl_3$ were determined in the vicinity of 1 Mrad/hr at temperatures between –57 and 63°C. Qualitative effects of dose rate variations were found to be in accord with expectations based on a homogeneous free-radical mechanism and did not derive from track–track overlap. Numerical solutions of the steady-state equations for the major organic free-radical intermediates ($CHCl_2\cdot$ and $CCl_3\cdot$) were shown to be quantitatively consistent with the proposed homogeneous free-radical mechanism between 0 and 63°C if spur reactions were assumed to function independently of the homogeneous mechanism. The form of the numerical solutions provided a basis for explaining effects of dose rate up to 10^4 Mrads/hr at 25°C. The rate constant for the reaction, $CHCl_2\cdot + CHCl_3 \rightarrow CH_2Cl_2 + CCl_3\cdot$, was evaluated at 0, 26, 48, and 63°C and is shown to be represented by $k = 1.6 \times 10^{-16}\, e^{-6700/RT}$ cc/molecule sec in liquid $CHCl_3$. (auth)

3130 EMERGENCY-DOSE MEASUREMENT BY MEANS OF AQUEOUS SOLUTIONS OF POTASSIUM NITRATE AND SODIUM NITRATE. Orban, G.; Patko, J.; Berta, I. (Lajos Kossuth Univ., Debrecen, Hungary). Acta Phys. Chim. Debrecina, 11: 13-18(1965).

The radiolytic decomposition of aqueous solutions of potassium and sodium nitrate was investigated. The nitrite ions produced by the effect of the irradiation were detected with Griess-Ilosvay reagent. The concentration of the nitrite ions was determined by measuring the optical density at 520 mm after adding the reagent to the irradiated solution. According to the measurements 2.5M KNO_3 solution is the most suitable for chemical dosimetry in the energy range from 80 keV to 1.3 MeV. (auth)

3131 CHEMICAL FORMS OF STABILIZATION OF RADIOACTIVE IODINE ATOMS FORMED WHEN CESIUM CHLORIDE CRYSTALS ARE IRRADIATED WITH 660 BeV PROTONS. Dema, I.; Zaitseva, N. G. Radiokhimiya, 8: 88-98(1966). (In Russian).

Studies were made on the effects of radiation dose and subsequent annealing on relative yield of radioactive iodine in oxidized and correspondingly reduced forms, when crystalline salts of cesium chloride and cesium nitrate are irradiated with 660 BeV protons. The results of kinetic investigation of the thermal annealing of the irradiated crystals permit calculation of the rate of conversion of iodine from oxidized into reduced state and the energy of activation of this process, and also determination of the order of reaction. It was found that the mechanism of reaction of recoil atoms from lattice defects of the irradiated crystals plays an important role in stabilization of chemical forms of radioactive iodine. (JPRS)

3132 PRODUCTION OF SPOTS OF RADIOACTIVE MATERIALS BY EVAPORATION IN A CARRIER-GAS STREAM. Roeder, E.; Herrmann, G. (Univ., Mainz). Nucl. Instrum. Methods, 42: 323-4(July 1966). (In German).

Deposits of radioactive materials were prepared by sending the substance, in a carrier gas at normal pressure, through a nozzle onto a cooled foil. The apparatus is shown. By using a nozzle with a diameter of 2.0 mm, preparations of about 3 mm in diameter could be obtained in good yield. Examples of the preparation of various isotopes are given. (M.C.G.)

3133 RADIATSIONNAYA KHIMIYA POLIMEROV. (Radiation Chemistry of Polymers). Karpov, V. L. (ed.). Moscow, Izdatel'stvo Nauka, 1966. 408p.

Ninety reports presented at the Symposium on Polymer Radiation Chemistry, November 23–28, 1964 in Moscow, include data on γ-induced polymerization, radiation synthesis of graft polymers, radiochemical transformations in polymers, radioinduced cross-linking and modification in polymers, and radiation stability of polymer materials. (R.V.J.)

3134 γ RADIOLYSIS OF DISULFIDES IN DILUTE AQUEOUS SOLUTIONS. Purdie, John W. (Defence Research Board, Ottawa). 10p. (CONF-660636-2). ORAU. Gmelin, AED-CONF-66-183-2.

From 49th Canadian Chemical Conference, Saskatoon, Canada.

The radiolysis of cystine was studied in both aerated and deaerated solutions of 3×10^{-4} M cystine with a total radiation dose of 10,000 Rads of ^{60}Co γ rays. A modified Technicon Amino Acid Analyzer was used to analyze the products, and since many of them were acids, an anion–exchange column was added to the analyzer to separate them. The following six products were obtained and identified, and G–values are reported for them: cysteine sulfinic acid, cysteic acid, cysteine, cystine trisulfide, cysteine thiosulfonic acid, and cysteine thiosulfuric acid. (B.L.M.)

Radiochemistry

Refer also to abstracts 2939, 4203, and 4413.

3135 THE OCCURRENCE OF 1,4-ADDITION IN THE REDUCTION OF α,β-UNSATURATED KETOSTEROIDS WITH RECOIL TRITIATED LITHIUM ALUMINIUM COMPLEX-HYDRIDES. Mantescu, Constanta; Genunche, Ana (Inst. of Atomic Physics, Bucharest). Tetrahedron Lett., No. 46, 5675-8(Nov. 1966).

In experiments performed with recoil tritiated reagents in certain ratios, to obtain tritiated sterols (that is, with $LiAlH_4$-t: substrate (1:4 mmoles), $LiAlH_4$-t:$AlCl_3$:substrate (1:2:1 mmoles), and lithium-tetrakis-(N-dihydropyridyl)-aluminate:substrate (1:1 mmoles)), the 1,4 addition was often observed, leading to the saturated ketones. In one instance, 1,4 addition followed by the 1,2 addition resulted in a saturated carbinol. When the Δ^4-3 keto and $\Delta^{5,16}$-20 keto systems of α,β unsaturated ketosteroids were studied, excess $LiAlH_4$-t reduced $\Delta^{5,16}$-pregnadiene-3 β-ol-20-one to the saturated carbinol, Δ^5-pregnene-3-20-diol in 95% chemical yield, by addition to the β-carbon giving the enol of the corresponding saturated ketones, which was further reduced to the saturated alcohol. This reaction was performed practically in one step. The saturation of the double bond with $LiAlH_4$-t occurred only in the $\Delta^{5,16}$-20-one reduction, the Δ^4-3-one giving only the allylic alcohol. Reduction with $LiAlH_4$-t:$AlCl_3$ of 17 β-methyl-androsten-17 β-ol-3-one gave the saturated ketone by the stabilization of the enol obtained at the 1,4 addition. In the reduction with tritiated lithium-tetrakis-(N-dihydropyridyl)-aluminate, while the Δ^4-3-one in 17α-methyl-Δ^4-androstene-3-one-17β-ol and Δ^4-androstene 17 α-ol-3-one were totally inactive towards this reagent, from $\Delta^{5,16}$-pregnadiene-3 β-ol-20-one only the Δ^5-pregnene-3 β-ol-20-one was obtained in 73% yield. On the other hand, the Δ^4-3-one system in Δ^4-pregnene-3-20-dione, in 17β-propionyloxy-Δ^4-androstene-3-one, and in ethynyl-testosterone was also reduced to the saturated ketone. (BBB)

3136 RADIOLUMINESCENCE FROM β-RADIATION OF ^{147}Pm. Serra, Maria (Univ., Rome). Ric. Sci., 36: 662-4(July 1966). (In Italian).

A technique for producing a luminous source excited by β radiation from ^{147}Pm is described; activities employed reached up to 2000 mCi. The equipment used is described. (auth)

3137 PHASE INFLUENCE ON THE CHEMICAL BEHAVIOR OF ^{132}I FORMED BY DECAY OF ^{132}Te IN AN ORGANIC MILIEU. Llabador, Y.; Adloff, J. P. (Centre de Recherches Nucleaires, Strasbourg). Radiochim. Acta, 6: 49-50(Aug. 1966). (In French).

The behavior of ^{132}I was examined when the parent atom was present in an organic structure of diphenyl–tellurium and in solutions of tellurium tetrachloride in benzene. In these two cases the only radiosynthesis product detected was iodobenzene $C_6H_5{}^{132}I$. The iodobenzene yield was determined as a function of the temperature of the solutions of $TeCl_4$ in benzene. There was a sharp discontinuity at the transition from the liquid phase to the solid phase, and below the freezing temperature the yield was independent of the temperature. In the case of diphenyl–tellurium, the yield was independent of the temperature. For solutions of diphenyl–tellurium in benzene, the organic fraction of ^{132}I depended neither on the temperature nor the composition of the mixture. The behavior of the $^{132}TeCl_4$–benzene solution was ascribed to a coalescence of the $TeCl_4$ molecules at the moment of solidification, causing a partial separation of the two components in the solid phase. (J.S.R.)

3138 EXCHANGE BETWEEN ATOMIC AND MOLECULAR HYDROGEN AT ENERGIES ABOVE THRESHOLD. Seewald, D.; Gersh, M.; Wolfgang, Richard (Yale Univ., New Haven). J. Chem. Phys., 45: 3870-1(Nov. 15, 1966).

The exchange reaction between atomic and molecular hydrogen was investigated at energies above threshold by studying the reactions of recoil tritium atoms with hydrogen and deuterium. Reactivity integrals for the reactions, $T + H_2 \rightarrow TH + H$ and $T + D_2 \rightarrow TD + D$, were obtained. The isotope effect, I_{H_2}/I_{D_2} was obtained using 1:1 mixtures of H_2–D_2 at various moderator concentrations. A potential-surface-trajectory method was used to compute cross sections as a function of energy. (J.G.B.)

3139 FORMATION OF ELEMENTARY SULFUR IN THE NEUTRON IRRADIATION OF AMMONIUM SULFATE. Kunz, G.;

Lieser, K. H. (Lehrstuhl fuer Kernchemie, TH, Darmstadt, Ger.). Radiochim. Acta, 6: 51(Aug. 1966). (In German).

Ammonium sulfate crystals were irradiated with reactor neutrons and it was found that the ^{35}S activity can be detected in the form of elementary sulfur, sulfite, and sulfate. Approximately half of the ^{35}S was in the form of elementary sulfur. The reactions of sulfur recoil atoms in the neutron-irradiated ammonium sulfate are described and shown graphically. It is assumed that the ^{35}S atom formed leaves the sulfate molecule as a positive ion as a result of recoils. After they come to rest, the positive sulfur atoms can react with either oxygen or electrons. Tempering at room temperature for a long period of time leads to the formation of sulfur molecules. (J.S.R.)

Separation Processes

Refer also to abstract 2951.

3140 (AEET–253) PILOT PLANT STUDIES ON THE SEPARATION OF RARE EARTHS BY ION EXCHANGE. Bhat, T. R.; Rao, T. V.; Phatak, G. M. (Atomic Energy Establishment, Trombay (India). Chemistry Div.). 1966. 41p. Dep. mn.

The principles and the various factors to be considered in the ion exchange separation of rare earths on a large scale are discussed. Data are presented on the preliminary separation of commercial "didymium carbonate" into lanthanum-rich and neodymium-rich fractions by fractional precipitation with ammonia. The effect of distance of elution on the yields of "spec.pure" and A. R. grade oxides of various elements using "didymium carbonate", lanthanum-rich and neodymium-rich fractions as starting materials was studied. On the basis of these data the chemical requirements for the separation of rare earths are evaluated. A method for the recovery of copper and EDTA from waste solutions is also reported. Some details are given on the extraction of heavy rare earths from the mineral samarskite. (auth)

3141 (ANL–7186) LABORATORY INVESTIGATIONS IN SUPPORT OF FLUID-BED FLUORIDE VOLATILITY PROCESSES. PART XI. VAPOR–LIQUID EQUILIBRIA IN THE SYSTEM URANIUM HEXAFLUORIDE–PLUTONIUM HEXAFLUORIDE. Steidl, D. V.; Trevorrow, L. E.; Steindler, M. J. (Argonne National Lab., Ill.). Apr. 1966. Contract W-31-109-eng-38. 26p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Vapor-liquid equilibrium data of the system UF_6-PuF_6 were obtained on dilute solutions of PuF_6 in UF_6 (1–48 m/o PuF_6) at 73 to 89°C. Results indicate that the activity coefficients of both UF_6 and PuF_6 are close to unity, and hence the mixtures behave ideally in the concentration range studied. A fractional distillation column for the distillation of UF_6-rich mixtures can be designed assuming ideal behavior of UF_6-PuF_6 solutions. (auth)

3142 (ANL–7197) GENERALIZED COMPUTER PROGRAM FOR FLOWSHEET CALCULATION AND PROCESS DATA REDUCTION. Koppel, L. B.; Alfredson, P. G.; Anastasia, L. J.; Knudsen, I. E.; Vogel, G. J. (Argonne National Lab., Ill.). Apr. 1966. Contract W-31-109-eng-38. 31p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A generalized computer program, PACER-65, was developed and utilized for flowsheet calculations and process-data reduction. PACER-65 is an executive program in which material- and energy-balance equations, conversion factors, etc., for each processing step are described by separate subroutines. The program plans the sequence of the calculations and calls the subroutines in the order required to determine all desired properties of the process streams. The effects of changes in the process flowsheet or variation of processing conditions are readily evaluated. The PACER-65 method has also been adapted for process-data reduction. In this case, the subroutines incorporate calibration data for flow-metering instruments, etc., as well as equations required to perform the various calculations. Examples of these applications to fluid-bed volatility processes are presented. (auth)

3143 (ISO-SA-28) USE OF NEUTRON DETECTORS IN CONTINUOUS SOLVENT EXTRACTION CONTROL. Lyon, R. Y. (Isochem Inc., Richland, Wash.). Oct. 7, 1966. Contract AT(45-1)-1851. 15p. (CONF-661025-2). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From Pacific Northwest Regional Meeting, American Institute of Chemical Engineers, Richland, Wash.

The principles of neutron detection devices and their application in a continuously operating solvent extraction system at Hanford's Plutonium Reclamation Facility are described. A practical application in column control and removal of uranium contaminants is described, with some suggestions for other applications of neutron detection instruments. (auth)

3144 (ISO-SA-29) DEVELOPMENT OF A CONTINUOUS DISSOLVER FOR PLUTONIUM SCRAP. Lorenzen, C. A. (Isochem Inc., Richland, Wash.). Oct. 7, 1966. Contract AT(45-1)-1851. 17p. (CONF-661025-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Pacific Northwest Regional Meeting, American Institute of Chemical Engineers, Richland, Wash.

The source of "slag and crucible", a plutonium-bearing scrap, its composition, and the basic chemistry for dissolution are discussed. The factors which influenced the development of a geometrically favorable, continuous, remotely operated dissolver, and the capabilities of this dissolver are reported. (auth)

3145 (MCW–1512) PURIFICATION OF NATURAL THORIUM SCRAP MATERIALS BY A SOLVENT EXTRACTION PROCESS. Nelson, E. N.; Robertson, W. J. (Mallinckrodt Chemical Works, Weldon Spring, Mo. Uranium Div.). Oct. 31, 1966. Contract W-14-108-eng-8. 18p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A flow sheet was developed for conversion of the Weldon Spring uranium refinery to a thorium refinery. A successful thorium campaign was conducted in which about 240 tons of thorium was purified. The flow sheet behaved as expected with the exception of the solvent treatment system, which required some change in both process and equipment. (auth)

3146 (NYO–755–3) SEPARATION OF ISOTOPES. Annual Progress Report. Taylor, T. I. (Columbia Univ., New York. Dept. of Chemistry). Sept. 1, 1966. Contract AT(30-1)-755. 165p. (CU–19–66–AT(30-1)-755). Dep. mn. CFSTI $5.00 cy, $1.00 mn.

Developments are reported for studies on: mechanisms of chemical exchange between NO and HNO_3 from experiments in an exchange column; ^{18}O and ^{13}C isotope effects in solvent carrier systems of amine carbamates and CO_2; dual-temperature system for the concentration of D by the exchange of methylacetylene with H_2O; separation and analysis of isotopes by low temperature gas chromatography; heterogenous catalysis of the exchange of ^{18}O between CO_2 and H_2O; and solvent effects on the heat of reaction of CO_2 with amines. (P.C.H.)

3147 SEPARATION OF BINARY MIXTURE OF ISOTOPES IN AN ION EXCHANGE COLUMN WITH SUPERIMPOSED DIRECT CURRENT ELECTRIC FIELD. Kurin, M. N.; Tikhomirov, I. A.; Tikhonov, G. S. (Tomskii Polytechnical Inst., USSR). Zh. Fiz. Khim., 40: 2177-84(Sept. 1966). (In Russian).

Differential equations for the separation of isotopic ions in the case of ion exchange with superposition of a direct-current electric field were derived. Equations were obtained to calculate the time for the establishment of stationary conditions, the BETT size, and the distribution of the concentration of light and heavy isotopes both in solution and along the column. Experimental and calculated data were in agreement, confirming the accuracy of the assumptions on which the derivation of the equations were based. (tr-auth)

3148 EXTRACTION OF LANTHANIDES AND ACTINIDES WITH ALKYLPHOSPHINE OXIDES. PART I. THE EXTRACTION OF NITRIC ACID WITH TRI-n-BUTYLPHOSPHINE OXIDE. Goffart, J.; Duyckaerts, G. (Laboratoire de Chimie Analytique et Nucleaire, Liege). Anal. Chim. Acta, 36: 499-507(Dec. 1966). (In French).

The distribution of TBPO, water, and nitric acid has been measured between an aqueous phase and various inert diluents at 25°. The results allowed the determination of the apparent stability constants for two molecular complexes, $TBPO \cdot HNO_3$ ($K_1' = 17.5 \pm 1.3$ (mole/l)$^{-2}$ (benzene); 20.1 ± 0.8 (mole/l)$^{-2}$ (toluene); 11 ± 2 (mole/l)$^{-2}$ (n-hexane)) and $TBPO \cdot 2\,HNO_3 \cdot H_2O$ ($K_2' = (2.9 \pm 0.3)10^{-3}$ (mole/l)$^{-2}$ (benzene)). (auth)

3149 BASE-CATALYSED HYDROGEN-EXCHANGE IN SOME SUBSTITUTED [1-^{3}H]ACETYLENES. Eaborn, C.; Skinner, G. A.; Walton, D. R. M. (Univ. of Sussex, Brighton, Eng.). J. Chem. Soc. (B), No. 10, 989-90(1966).

The rates of detritiation of $X \cdot C \equiv C \cdot {}^3H$ compounds (X = $ClCH_2$, ICH_2, $BrCH_2$, Alkyl, $PhCH_2$, Ph, and Me_3Si) by buffered water–methanol (4 : 1 v/v) (pH ca 8.05) were measured at 25°. For the compounds with X = $HalCH_2$ or Alkyl, the effects of substituents correlate reasonably well with their Taft σ^*-constants. The compounds $PhC \equiv C^3H$, and particularly, $Me_3SiC \equiv C^3H$ are more reactive than would be expected from operation of inductive effects alone, and it is suggested that in these cases there is some conjugative withdrawal of electrons from the alkynyl group. (auth)

3150 INVESTIGATION OF COMPLEX FORMATION IN NONAQUEOUS SOLUTIONS. VII. EXTRACTION OF NEPTUNIUM(V) BY TRIBUTYLPHOSPHATE. Usachev, V. N.; Chaikhorskii, A. A. Radiokhimiya, 8: 48-51(1966). (In Russian).

The extraction of Np(V) and the determination of the extent of its solvation with tributylphosphate (TBP) were studied. Solutions of Np(V) were obtained by reduction of hexavalent neptunium in 0.5 M nitric acid with sodium nitrite. The completeness of reduction was verified spectrophotometrically. In addition, immediately prior to the experiment, the solution in question was treated twice with a 30% TBP solution to remove any tetra- and hexavalent neptunium still in the solution. The extraction of Np(V) with TBP was studied as follows: 5 ml of a solution of Np(V) ($1.11 \cdot 10^{-4}$ M) was agitated three times for five minutes each time, with a 30% TBP solution with nitric acid at a concentration of 0.5, 1.0, and 1.3 M. The extracting agent was first brought into contact with the corresponding solutions containing all the components (nitric acid, sodium nitrite) except Np(V). Np(V) distribution coefficients at the indicated nitric acid concentrations had low values, although upon repeated extraction recovery of neptunium became appreciable. (JPRS)

3151 CALCULATION OF THE EQUILIBRIUM CONSTANT OF THE ISOTOPIC EXCHANGE REACTION BETWEEN METHYL BORATE AND THE BORATE ION. Turq, Pierre; Chemla, Marius (Faculte des Sciences, Orsay, France). Compt. Rend., Ser. C, 263: 749-52(Sept. 19, 1966). (In French).

By use of the vibration spectra of $B(OCH_3)_3$ and the borate ion, the separation factor of the ^{10}B and ^{11}B isotopes in the exchange reaction between $B(OCH_3)_3$ and the borate ion was calculated. Because of the uncertainties in the origin of the lines, the extreme values at 67°C are equal to 1.015 and 1.045, and the most probable value is 1.035, in agreement with the experimental results. (tr-auth)

3152 MICRODISTILLATION TECHNIQUE FOR SEPARATION OF MICRO AMOUNTS OF CHLORIDE FROM PLUTONIUM AND URANIUM SOLUTIONS. Elsheimer, H. Neil; Johnston, A. L.; Kochen, Robert L. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. Anal. Chem., 38: 1684-7(Nov. 1966).

A microdistillation technique and a special cell were devised for separating micro amounts of Cl from Pu and U solutions with potential application to other actinide and nonactinide solutions. The method consists of oxidation of a Cl^--containing solution with an appropriate oxidant and distillation of the resulting Cl_2 into a slightly basic solution. An Ar sweep is employed while the cell is immersed in a constant-temperature bath. The Cl^- distillate is analyzed spectrophotometrically utilizing the $FeSCN^{+2}$ complex method. As much as 80% of the Cl^- can be reproducibly recovered in solutions containing up to 50 μg of Cl^-. Feasible oxidants are either $Ce(NO_3)_4$ solution or a suspension of PbO_2 in H_2SO_4. Precision studies on 14 1-ml aliquants of a plutonium nitrate solution gave a mean Cl^- recovery of 8.9 μg with a standard deviation of ±1.1 μg. (auth)

3153 ION EXCHANGE PROPERTIES OF VANADIUM FERROCYANIDE. 1. EXPERIMENTS UNDER STATIC CONDITIONS. Krtil, Josef (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Jad. Energ., 12: 224(June 1966). (In Czech).

The ion exchange properties of vanadium ferrocyanide are described. The use of vanadium ferrocyanide for isolation and separation of fission products was investigated. Rb, Cs, Sr, Ce, Ru, and Zr were used in the study. Influence of the acidity and of the presence of Na and NH_4 salts on the sorption of these ions is described, and selectivity coefficients for some ion pairs are discussed. (JPRS)

3154 USE OF ION EXCHANGERS IN HYDROMETALLURGY. Stamberg, Karel; Prochazka, Jaroslav J. (Czechoslovak Atomic Energy Commission, Prague). Chem. Listy, 76: 770-82(June 1966). (In Czech).

Ion exchangers are used in the treatment of U ores; in some instances ion exchangers are used in Au mining, and for the separation of Re from Mo. Columns filled with ion exchangers as a solid phase are discussed. The differences in ion exchangers due to their respective methods of production, are evaluated. Different selectivities of various ion exchangers are discussed. (JPRS)

3155 USE OF NONAQUEOUS SOLVENTS FOR ISOLATION OF RADIOACTIVE ^{22}Na FROM IRRADIATED MAGNESIUM. Rudenko, N. P.; Zhukovskaya, A. S. Radiokhimiya, 8: 63-6 (1966). (In Russian).

Studies were made in which acetone and dioxane were substituted for ethanol in a previously reported procedure for recovering ^{22}Na from irradiated magnesium. It was found that the nature of the organic solvent added to the precipitate of magnesium sulfate did not affect the composition of the crystal hydrate formed. The solubility of magnesium sulfate in ethanol, acetone, and dioxane, and in their mixtures with water at 20°C was determined. The desorption of ^{22}Na from the surface of crystalline magnesium sulfate by these solvents was studied. It was established that solutions of acetone and dioxane containing 10 to 20% water exceed ethanol in desorptive capacity and are preferred for recovering radioactive ^{22}Na from a magnesium target. (J.G.B.)

3156 FUEL RECYCLE SYSTEM IN A MOLTEN SALT REACTOR. McNeese, L. E.; Scott, C. D. (to U. S. Atomic Energy Commission). U. S. Patent 3,278,387. Oct. 11, 1966.

A continuous method was developed for reprocessing spent molten-salt reactor fuels. A portion of the molten salt is removed from the reactor core and fluorinated to remove uranium as UF_6 along with volatile fission product fluorides. The uranium-depleted carrier salt remaining in the fluorinator reactor is further decontaminated from high cross section fission products to provide purified carrier salt, and the UF_6 is separated from the volatile fission products by sorption-desorption on a bed of NaF. The purified UF_6 and carrier salt, which contains a portion of UF_4, are recombined along with needed make-up salt in a hydrogen-molten salt reductor by contacting with hydrogen to reduce the UF_6 to UF_4 in the molten salt. Thereafter a portion of the reconstituted carrier salt is returned to the reactor core. (AEC)

3157 PROCESS FOR DECLADDING ZIRCONIUM FROM ZIRCONIUM CLAD NUCLEAR FUEL ELEMENTS. Bartlett, C. B.; Wirsing, E.; Hatch, L. P. (to U. S. Atomic Energy Commission). U. S. Patent 3,294,492. Dec. 27, 1966.

A process for recovering uranium from zirconium-clad, uranium-bearing nuclear fuel elements is described, which comprises immersing the clad element in a bed of inert particles fluidized with a gas composed of 20–90 vol % oxygen and 10–80 vol % hydrogen fluoride while maintaining the bed at a temperature from 500 to 800°C until the uranium is exposed. The uranium is recovered by fluidizing the bed with fluorine at a temperature of from 400 to 450°C. (AEC)

3158 METHOD FOR SEPARATING AND CONCENTRATING ISOTOPES. Kakihana, Hideo (to Japan Atomic Fuel Corp.). Japanese Patent 1965-20000. Sept. 6, 1965. Filed June 21, 1963.

A method is proposed for separating and concentrating isotopes by electrophoresis. By using an ion exchanger on which direct current is applied to produce a potential gradient, ion-migration bands were formed by repeatedly supplying one species of different kinds of compounds to form a large number of the ion boundaries for the heterogeneous ions. In this method, the separating efficiency is not hindered. The amount of electric power consumed is not large since the electric migration of the ion pairs is hindered. Compared with the aqueous solution method, the separating efficiency is high because of the lower degree of ion hydration. In case of a granular ion exchanger, a reverse migration of the ion pairs is observed, but this is not seen in the proposed method. (NSA of Japan)

3159 METHOD OF REMOVING RADIOACTIVE CONTAMINATIONS FROM LIQUIDS. Heise, Otto; Schimmel, Wolfgang (to VEB Atomkraftwerk Rheinsberg mit Betriebsteil Berlin). German Patent 1,228,009. Nov. 3, 1966. Filed Feb. 9, 1961.

The method comprises the evaporation of the liquid at exceptionally reduced pressure, the height of which is varied repeatedly. (Gmelin Inst.)

3160 FURNACE FOR THE PRODUCTION AND REPROCESSING OF NUCLEAR FUEL CARBIDES. Wurm, Joseph Gerard; Beucherie, Pierre (to EURATOM). German Patent 1,221,203. July 21, 1966. Filed July 5, 1963.

An induction furnace, in which metal halides of nuclear fuel and carbon are treated at high temperatures and reduced pressure, comprises a water-cooled field concentrator that extends upward from the crucible in such a way that a dome shaped condenser for the condensation of the rising halides is obtained (condenser-concentrator unit). (Gmelin Inst.)

3161 METHOD FOR PROCESSING ALUMINUM-CONTAINING NUCLEAR FUELS. Thoma, R. E.; Bennett, M. R.; Ullmann, J. W. (to U. S. Atomic Energy Commission). U. S. Patent 3,273,973. Sept. 20, 1966.

A non-aqueous method is described for processing aluminum-containing nuclear fuels by contacting the fuel with a molten fluoride salt solvent of $KF-ZrF_4$ at a temperature no greater than 658°C while passing anhydrous hydrogen fluoride through the melt. The dissolved fuel values may subsequently be recovered by conversion to the volatile hexafluoride by contacting the melt with gaseous fluorine while maintaining the melt at a temperature between 500 and 600°C. (AEC)

3162 POLONIUM RECOVERY. Moore, Raymond H. (to U. S. Atomic Energy Commission). U. S. Patent 3,271,320. Sept. 6, 1966.

A method for recovering polonium from a solution in bismuth metal is described. After melting the solution cerium metal is added thereto to precipitate cerium bismuthide. This precipitate carries the polonium that is thus separated from the bulk of the bismuth. (AEC)

3163 CALIFORNIUM AND EINSTEINIUM SEPARATION. Knighton, James B.; Steunenberg, Robert K. (to U. S. Atomic Energy Commission). U. S. Patent 3,276,861. Oct. 4, 1966.

Californium and einsteinium are separated from each other and from other elements by introducing the material to be separated into a molten magnesium–chloride-containing salt, adding a molten magnesium–zinc alloy containing 2 to 10 weight percent magnesium, separating a salt phase containing einsteinium and californium from an alloy phase containing the other elements, adding molten magnesium–zinc metal containing 60 to 90 weight percent magnesium to the salt phase, and separating a metal phase containing californium from a salt phase containing einsteinium. (AEC)

3164 METHOD OF SEPARATING URANIUM AND PLUTONIUM. Jonke, Albert A.; Steunenberg, Robert K.; Vogel, Richard C.; Steindler, M. J.; Adams, M. D. (to U. S. Atomic Energy Commission). U. S. Patent 3,294,493. Dec. 27, 1966.

Uranium and plutonium are separated by fluorination in a fluidized bed with gaseous bromine pentafluoride, gaseous bromine trifluoride, or mixtures thereof at an elevated temperature. Uranium hexafluoride is volatilized and plutonium tetrafluoride remains in the bed. (AEC)

3165 METHOD FOR SEPARATING MEMBERS OF ACTINIDE AND LANTHANIDE GROUPS. Moore, F. L. (to U. S. Atomic Energy Commission). U. S. Patent 3,276,849. Oct. 4, 1966.

Actinides and lanthanides are separated from an acidic aqueous solution by using a quaternary ammonium compound as an organic extractant in the presence of thiocyanate values. (AEC)

3166 METHOD FOR REMOVING LANTHANIDES AND TRIVALENT ACTINIDES FROM AQUEOUS NITRATE SOLUTIONS. Moore, F. L. (to U. S. Atomic Energy Commission). U. S. Patent 3,294,494. Dec. 27, 1966.

Trivalent actinides and lanthanides are extracted from an acidic nitrate-containing aqueous solution with an organic solution of a quaternary amine. (AEC)

3167 CONTINUOUS-GAS-PHASE VOLATILITY PROCESS. Cathers, G. I.; Mailen, J. C. (to U. S. Atomic Energy Commission). U. S. Patent 3,275,422. Sept. 27, 1966.

An improved method for removing neutron-irradiated nuclear fuels from fused salt mixtures is described. The fused salt mixture is heated to a molten state, dispersed into salt droplets and contacted with gaseous fluorine at a temperature at least as great as the liquidus temperature of the salt mixture, with the volatilized hexafluoride product being subsequently recovered from the salt mixture. (AEC)

3168 RECOVERY OF ACTINIDES FROM HALITE DEBRIS. Karraker, D. G.; Perkins, W. C. (to U. S. Atomic Energy Commission). U. S. Patent 3,275,421. Sept. 27, 1966.

A process is described for the recovery of actinide values from halite debris resulting from a nuclear detonation in halite strata. Finely divided halite debris is contacted with water to dissolve substantially all of the salts and the resulting insoluble residue containing the actinide values is treated with a soluble ammonium salt, such as ammonium carbonate, to metathesize insoluble sulfates in the residue. The metathesized residue is then dissolved in a mineral acid, such as nitric acid, and the dissolved actinides recovered by conventional ion exchange or solvent extraction processes. (auth)

3169 PROCESS FOR THE REMOVAL OF METAL CORROSION PRODUCTS FROM A SOLUTION OF HYDRAZINE AND ETHYLENEDIAMINETETRAACETIC ACID. Pitzer, Edgar C.; Fountain, George R.; Ciaranello, Joseph R. (to U. S. Atomic Energy Commission). U. S. Patent 3,272,738. Sept. 13, 1966.

A process is described for the removal of metal corrosion products consisting of iron, nickel, cobalt, and manganese from a solution of hydrazine and ethylenediaminetetraacetic acid by acidifying the solution with sulfuric acid to a pH of 1.0 to 1.5, adding potassium ferrocyanide in an excess of 10 mole per cent of the stoichiometric amount of the corrosion products to the solution whereupon a precipitate is formed, centrifuging the solution, and separating the precipitate from the solution. (AEC)

3170 PROCESS FOR SEPARATING RARE EARTH METAL VALUES. Firsching, Ferdinand H. (to Research Corp.). U. S. Patent 3,275,404. Sept. 27, 1966. Filed Oct. 7, 1963.

A method for separating rare earth metals by means of chelating or sequestering agents is described. An anion, which forms a relatively insoluble salt with the rare earth metal having the lesser chelate stability, is added to a solution containing a plurality of rare earth metal salts and at least two chelating agents and alters the composition of the resulting solution in a direction to decrease the solubility of such relatively insoluble salt. Hydroxyethylethylenediaminetriacetic acid (HEDTA) and diethylenetriaminepentaacetic acid (DTPA) are used as the chelating agents. Another method for preferential precipitation of a salt of the rare earth metal forming the complex of lesser stability with the sequestering agents can also be effected by altering the hydrogen ion concentration of the solution by absorption into the solution of a volatile base, such as ammonia, or a volatile acid, such as acetic acid. (P.C.H.)

3171 SEPARATION OF Hf AND Zr VALUES BY SOLVENT EXTRACTION. Owens, William H. (to Pittsburgh Plate Glass Co.). U. S. Patent 3,272, 590. Sept. 13, 1966. Filed Mar. 15, 1962.

A solvent extraction method for obtaining Zr and/or Hf free of undesirable Ti contamination is described. Titanium is effectively extracted from Zr and/or Hf by adding a peroxidizing agent to the extraction system, namely H_2O_2. The peroxidizing agent apparently converts the Ti (probably present as titanyl ion) to a peritanic acid form. Thus, the addition of H_2O_2 to an extraction system of an organic extractant such as TBP and aqueous HNO_3 results in the distribution of Ti in the HNO_3 fraction under conditions that otherwise lead to Ti distribution in the TBP. Titanium poor Hf or Zr is readily recovered from the organic extractant fraction. (P.C.H.)

3172 PURIFICATION OF MOLTEN SALTS. Knighton, James B.; Steunenberg, Robert K. (to U. S. Atomic Energy Commission). U. S. Patent 3,271,133. Sept. 6, 1966.

A process for purifying a fused salt containing fission products consists of contacting the fused salt with a binary alloy of aluminum and magnesium whereby essentially all of the rare earth fission products are extracted into the binary alloy, and the salt and metal phases are separated. (AEC)

3173 METHOD OF SEPARATING HAFNIUM FROM ZIRCONIUM. Chandler, Horace W. (to Isomet Corp.). U. S. Patent 3,276,862. Oct. 4, 1966. Filed Oct. 24, 1962.

A nonaqueous method is described for separating Hf from Zr. Vapors containing both $ZrCl_4$ and HfClF are passed over a bed containing ZrO_2 and HfO_2 at elevated temperature. The $HfCl_4$ reacts with the ZrO_2 to form volatile $ZrCl_4$, which mixes with the $ZrCl_4$, previously in the vapor phase. The $HfCl_4$ probably enriches the bed by being converted to HfO_2. In this method no solvent extraction step is necessary to separate the Hf from the Zr; the Hf-free Zr is immediately available, as $ZrCl_4$, for reduction to metallic Zr by reaction with Mg. (P.C.H.)

EARTH SCIENCES

Geology

Refer also to abstracts 3188, 3230, and 3235.

3174 (ORNL–3941) STATUS REPORT NO. 6 ON CLINCH RIVER STUDY. Morton, R. J. (ed.) (Oak Ridge National Lab., Tenn.). Nov. 1966. Contract W-7405-eng-26. 84p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Data are presented on the field and laboratory work of the Clinch River study during the period December 1, 1963 to December 31, 1964. The overall objectives of the program are discussed including the sampling and analysis of the waters of the Clinch and Tennessee Rivers, monitoring of radionuclides in river bottom sediments, biological studies of fish and other aquatic organisms, hydrologic measurements and analyses of the Clinch River, safety evaluation studies, and computer simulation of the fate of radioactive wastes in streams. (R.C.K.)

3175 (UCRL-16806, pp 53) SOME ANALYTICAL RESULTS IN ORGANIC GEOCHEMISTRY. Belsky, Theodore; McCarthy, Eugene D.; Van Hoeven, William (California Univ., Berkeley. Lawrence Radiation Lab.).

Progress is reported on a search for evidence of life among geologically well-characterized ancient shales and oils, with emphasis on the diagenetic processes responsible for the occurrence of hydrocarbons. Preliminary results are reported on the analysis of the hydrocarbon distribution pattern in Pierre Shale of the Late Cretaceous Period and in modern organic deposits from Mud Lake, Florida. (C.H.)

3176 THE $^{40}Ca/^{44}Ca$ AND $^{18}O/^{16}O$ ISOTOPIC RATIOS IN SOME CARBONATE ROCKS. Artemov, Yu. M.; Knorre, K. G.; Strizhov, V. P.; Ustinov, V. I. (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow. All-Union Inst. of Mineralogical Resources, Moscow). Geokhimiya, No. 11, 1355-9(Nov. 1966). (In Russian).

Oxygen and calcium isotopic content in carbonate rocks was studied. Isotopic analysis of calcium content revealed considerable variation in the ratio of $^{40}Ca/^{44}Ca$ in natural materials. The error of mass spectrometric analysis of calcium isotopic content studied with CaI_2 was about 1%. Isotopic fractionation of calcium and various processes causing isotopic separation are discussed. (R.V.J.)

3177 RADIOACTIVITY IN DRINKING WATER IN THE UNITED KINGDOM: 1964 RESULTS. J. Brit. Waterworks Ass., 47: 764-71(Dec. 1965).

Throughout 1964 samples were taken regularly from 26 public drinking waters for determination of concentrations of ^{90}Sr and ^{137}Cs. Practically none of these isotopes was found in waters derived from deep wells sunk in chalk and sandstone at Brighton and Wolverhampton respectively. Only very low concentrations were detected in the Folkestone supply derived from shallow wells at Denge Beach and also in the South Lincolnshire water obtained from a deep borehole in limestone. Higher concentrations of ^{90}Sr were found in several underground supplies obtained in areas where untreated waters are known to be significantly contaminated bacteriologically. Average concentrations of both radioisotopes in the other supplies were generally slightly higher in 1964 than in the previous year. The average level of ^{90}Sr in the river-derived supplies regularly tested in 1964 was 0.83 pCi/l, omitting the Southampton supply from a chalk stream which contained only 0.10 pCi/l. Excluding London's River Thames water the average level of ^{137}Cs in the regularly tested river supplies was 0.085 pCi/l. The corresponding value for the Thames water was 0.32 pCi/l. Concentrations of only 0.009 pCi/l for both isotopes were found in a sample taken from the Wilmington Springs which derives its water from a Greensand area. The average concentration of ^{90}Sr in 12 reservoir waters was 2.25 pCi/l in 1964. The average annual values for individual supplies ranged from 1.01 to 3.11 pCi/l. Corresponding values for ^{137}Cs in the reservoir waters were 0.67 pCi/l with extremes of 0.11 and 3.42 pCi/l. The concentration of ^{90}Sr in the supply used by Lleyn Rural District Council in 1964 was about 25% higher than that in any of the other tested supplies. Strontium-90 concentrations in two other supplies from North Wales were slightly below the average value for all reservoir waters. Concentrations of ^{137}Cs in the three supplies covered a wide range and fell within the extreme values obtained for the other supplies in the United Kingdom. The average daily ingestion of ^{90}Sr and ^{137}Cs in drinking water in 1964 is estimated as 1.07 and 0.32 pCi per person respectively. These amounts are small compared with the average daily intake in the whole diet. Further measurements were made of the concentrations of all the principal fission products in selected drinking water supplies. Results are given also for the level of α activity in a number of samples. (BBB)

3178 LOW-LEVEL TRITIUM MEASUREMENTS IN WATER. Allen, R. A.; Smith, D. B.; Otlet, R. L.; Rawson, D. S. (Wantage Research Lab., Eng.). Nucl. Instrum. Methods, 45: 61-71(Nov.-Dec. 1966).

Tritium is widely dispersed throughout the atmosphere as water vapor, arising from cosmic ray interactions and as a product of thermonuclear explosions. The tritium becomes part of the hydrological cycle and is present in rainfall and surface waters from whence a proportion may enter the ground-water system. This isotope, of 12.26 y half-life, thus forms a useful natural tracer in the study of ground-water resources. Geiger-Müller and proportional gas counting systems have been developed for the routine determination of the tritium content of water at concentrations greater than about 50 TU (0.16 pCi/ml) for the proportional system and 100 TU for the G-M system. In addition an electrolytic tritium reconcentration unit using cleaned iron and iron-nickel electrodes is in operation giving a reconcentration factor of 15 with a volume reduction from 100 ml to 5 ml extending the overall limit of the system to 3 TU. (auth)

3179 NATURAL TRITIUM. Nir, A. (Weizmann Inst. of Science, Rehovoth, Israel); Kruger, S. T.; Lingenfelter, R. E.; Flamm, E. J. Rev. Geophys., 4: 441-56(Nov. 1966).

The subject of natural tritium is reviewed from the inception of the search for this isotope in 1932 until the present. Three sources of natural tritium are considered: production in the atmosphere by galactic cosmic rays, production in the atmosphere by solar-flare-accelerated particles, and accretion from the sun. A recalculation of the cosmic-ray production rate utilizing experimental data for the last solar cycle yields a worldwide average of $0.20 \pm .09$ triton/cm^2 sec during solar minimum and $0.16 \pm .09$ triton/cm^2 sec during solar maximum. Production of tritium by interaction of solar flare accelerated particles with the atmosphere is found to be less than 3% of the production by galactic cosmic rays. Calculations of the tritium decay rate from material balance, utilizing measured tritium concentrations of rain and ocean water corrected for synthetic tritium, are consistent within the limits of error with the production rate by galactic cosmic rays. The best estimate of the prebomb inventory corresponds to a decay rate of $0.5 \pm .3$ triton/cm^2 sec as compared with the estimated production rate of $0.19 \pm .09$ triton/cm^2 sec. In view of the large errors it is not possible to determine whether appreciable amounts of tritium are accreted from the sun. (auth)

3180 FAST MASS-SPECTROMETRIC METHOD FOR DETERMINING THE ^{18}O VARIATIONS IN NATURAL WATERS. Vetstein, V. E. Dopov. Akad. Nauk Ukr. RSR, No. 9, 1180-1 (1966). (In Ukrainian).

The persulphate method is used for the extraction of oxygen from natural waters for fast precision mass-spectrometric measurement of its isotopic composition. The results of measurements of the ^{18}O-variations are given for some samples of natural waters. (auth)

3181 TRANSPORTATION OF RADIOISOTOPES IN THE SOIL. Baetsle, L. H.; Maes, W. F.; Souffriau, J. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Mededel. Landbouwhogeschool Opzoekingssta. Staat Gent, 30: 933-40(1965). (In Flemish).

Transport of radioelements in the soil is closely dependent on hydrologic and physicochemical conditions in the soil. Study of the hydrology of the ground water table forms the basis for calculation and evaluation of migration of radioelements in soil. Classical methods for measuring the direction and speed of ground water flow are explained and illustrated by data obtained at this Center. By measurement of the coefficient of distribution of a radioelement under natural conditions of the medium, it is possible to obtain an indication of the relative migration of a radioactive point source in relation to the ground water. These coefficients are determined for ^{137}Cs, ^{90}Sr, and ^{144}Ce in sandy soil in which ^{144}Ce as a rare earth behaves as a colloid, ^{137}Cs is displaced from the soil at $1/_{50}$ the rate of the water molecules, and ^{90}Sr is transported by water in the soil at low pH but retarded by a factor of 2 to 3 at high pH. The dispersion coefficients express numerically the degree of dispersion of radioelements in soil materials. Two types of extension of soil contamination are discussed: that after continuous and discontinuous application of a radioactive solution. Continuous ap-

plication gives a cigar-shaped dispersion zone and discontinuous application a spherical or ellipsoidal one. The use of chemical barriers, such as HF and $K_2H_2Sb_2O_7$, to block migration of radionuclides in soil around nuclear installations is discussed. (BBB)

3182 NATURAL RADIOACTIVITY IN SOILS. Talibudeen, O. (Rothamsted Experimental Station, Harpenden, Eng.). Soils Fert., 27: 347-59(1964).

This review presents extensive data and numerous tables showing levels of natural and fallout levels of radioelements in soils under various conditions. About 90 references are cited. Also considered are applications of studies of natural radioactivity to soil science. The properties of radioelements found in nature, given in a table, are discussed to assess their contribution to the natural radioactivity of soils. Another table summarizes the calculated contribution of long-lived natural radioelements to the total radioactivity of soils from the Great Russian Plains. Two-thirds of the total is from potassium and thorium, over one-fifth from uranium, and about 7% from rubidium. Less than 0.5% is from ^{14}C, while the rare earth and other elements together contribute negligible amounts. The ratios of pairs of naturally radioactive elements sometimes provide information about the intensity of weathering of a soil profile, the composition of its parent material, and the pedological composition of the soil horizons. The most important of these pairs of elements are uranium and thorium, and uranium and radium. Some effects of pedological processes on these ratios are described. Radiocarbon dating of soil organic matter is also discussed. It is shown that fallout contamination, particularly from the long-lived fission products, can confuse the determination of the potassium, thorium, and uranium contents of soils by β and γ measurements unless suitable precautions are taken. Special methods of α, β, and γ assay of soil radioactivity are considered. (BBB)

3183 VARIATIONS IN THE DEPOSITION OF ^{32}Si. Aegerter, Simon (Univ., Bern). 44p. (In German). (CONF-660404-2): ORAU.

From Spring Meeting of the Swiss Physical Society, Bern.

The constancy of the $^{14}C/^{12}C$ ratio in atmospheric CO_2 is one of the essential assumptions for the utility of ^{14}C for age determination. Two periods of oscillation of this ratio are known and the reasons for these oscillations are discussed. Changes in the exchange between the individual reservoirs are considered. The electronic simulation of the ^{14}C behavior to determine the effect of special parameters was described and the results obtained are shown graphically. The variations in the deposition of ^{32}Si were measured on a series of ice samples from an ice tunnel of the Jungfrau. The extraction of ^{32}Si from the ice was done by means of silicate carrier with coprecipitation of FeOH. The ^{32}Si concentration was correlated with the age of the ice and the results shown graphically. The results show a marked oscillation and indicate that ^{32}Si is unsuitable for the age measurement of ice. (tr-auth)

Meteorology

Refer also to abstracts 2935 and 3182.

3184 METEOROLOGICAL EFFECTS ON ATMOSPHERIC CONCENTRATIONS OF RADON (^{222}Rn), RaB (^{214}Pb), AND RaC (^{214}Bi) NEAR THE GROUND. Hosler, Charles R. (Environmental Science Services Administration, Washington, D. C.). Mon. Weather Rev., 94: 89-99(Feb. 1966).

Radon measurements in air were obtained at Sterling, Va., about 25 mi west of Washington, D. C., and by two air sampling units installed at a 91-m tower facility at Tysons Corner, Va., 15 mi west of Washington, D. C. Thus atmospheric concentrations of radon were calculated from filtered radon daughter β activity, obtained from 1- and 15-m elevations at the rural site, and from 1- and 91-m elevations at the latter semi-rural site. Measurements were obtained from the successive filtration of air over 20-min periods for durations of several hours, during various meteorological conditions. The extent of secular equilibrium between radon and its daughter products in the atmosphere near the ground ($\leq$15 m) was determined from a calculation of the RaC/RaB atom ratio (ρ) in the air, derived from the measured rate of decay of the filtered β activity. Estimates of an effective residence time (τ) in the atmosphere of the radon conglomerate, based on either a continuous or single emission of radon into the air, are presented. The relation between ρ and τ for various weather conditions is discussed, as well as possible effects of (1) wind, (2) thermal stability, (3) atmospheric scavenging, and (4) precipitation on measured levels of natural radioactivity. Radon concentrations measured during an air pollution potential episode and during fumigation conditions are presented. In general, the response of measured β activity in the air to changes in the turbulent state of the atmosphere near the ground gives evidence of the feasibility of using naturally occurring radon and radon daughter products as tracers for determining atmospheric diffusivity. (BBB)

3185 ATMOSPHERIC CONTAMINATION BY FISSION PRODUCTS IN MILAN (BRERA). Santomauro, Luigi; Zagar, Ilse (Osservatorio Astronomico di Milano (Brera), Milan). Rend. Ist Lombardo Sci. Lett. A, 95: 717-54(1961). (In Italian).

Samples of radiation contamination at the Brera Observatory were analyzed by collection on filters and measurement of β activity. Daily data from Jan. 3, 1959 to Mar. 31, 1961 are tabulated, giving the duration of sampling (22 hours in general), hour at end of sampling (6 A.M. in general), activity measured in $\mu\mu Ci/m^3$ and in $d/min\ m^3$, time interval between end of sampling and counting (123 hours in general), direction and velocity of the wind at end of sampling, and the quantity and type of precipitation accumulated during the testing period. Activity was greatest in 1959, with max values (12 to 17 $d/min\ m^3$; 5 to 7.5 $\mu\mu Ci/m^3$) from Feb. 16 to 23, 1959. Data are graphed as daily recordings, weekly means, and monthly means, and they are tabulated in the same fashion. (BBB)

3186 RADIONUCLIDE COMPOSITION OF STRATOSPHERIC FALLOUT THREE YEARS AFTER THE ATMOSPHERIC NUCLEAR WEAPON TEST SERIES HAVE BEEN STOPPED. Allkofer, O. C.; Fox, J. M.; Hauser, H. (Univ., Kiel). Atomkernenergie, 11: 467-76(1966). (In German).

A quantitative total analysis of the beta- and gamma-ray emitting radionuclides of radioactive fallout in 1965 from the stratosphere and troposphere is presented. The results of this investigation lead to an estimation of the age of the radioactive debris of about three or four years. It is concluded that, in the main, fallout from the nuclear tests of the US at the equatorial region is detected, since the age of debris from the Russian polar tests is less than three years. The results of the analysis also lead to the conclusion that the mean energy of the fission neutrons of tests in the megaton range is about 9 or 10 MeV and not 6 or 7 MeV. Furthermore the analysis indicates that fractionation of global stratospheric fallout takes place only to a very low extent, and in this case fractionation will be restricted only to the first phase after a test explosion. The occurrence of the short-lived nuclides ^{95}Zr and ^{103}Ru is discussed and correlated to the Chinese nuclear test in May 1965. The results of the measurements lead to the conclusion that probably ^{235}U or ^{238}U enriched with ^{235}U respectively was used as a fuel. Finally, an estimation of the production rate per megaton TNT of the induced radionuclides ^{54}Mn and ^{57}Co is given from their relative intensities and their generating reactions discussed. (auth)

3187 CHANGES OF THE RADIOACTIVITY IN AIR IN VIENNA FROM 1958 TO 1965. Steinhauser, Ferdinand (Zentralanstalt fuer Meteorologie und Geodynamik, Vienna). Wetter Leben, 18: 45-54 (1966). (In German).

Charts are provided showing the results of measurement of radioactivity of the air in Vienna during the period 1958 to 1965. The sampling filters were exposed for 24 hr to an air current and 48 and 120 hr afterwards investigated for their content of radioactive matter. In general, a linear relation between the monthly mean values of the measurement at 120 hr and those 48 hr after exposure could be found. However, there were deviations from this result for some months when short-lived radioactive products predominated. During these months, a number of atomic explosions had taken place. An unusually high value of radioactivity was found from November 5 to 10, 1962 (up to $71 \times 10^{-12}\ \mu Ci/cm^3$). Then, the short-lived fraction of the radioactive material was above normal. On account of the observed wind direction and the fact that the same high value of radioactivity could not be found at observation stations further to the west, it is concluded that the place of origin must be located in a direction east or southeast of Vienna. (BBB)

3188 ON THE LOCALIZATION OF ^{90}Sr FALLOUT IN SOILS. Richter, D. (Univ., Jena, Ger.). Chem. Erce, 24: 67-76(1965). (In German).

Five soils typical of central Germany, including black soil from loess, variegated sandstone, bottomland, and shell lime were examined in 1961 for their ^{90}Sr content at levels of 0 to 20 and 20 to 40 cm depth. In the upper layers, the average decay rate/200 g soil was 37 cpm of ^{90}Sr. In the 20 to 40 cm level the average was 5 cpm/200 g of soil. These values were remeasured in 1963 and almost identical results were obtained for the soil at the 0 to 20 cm depth. These results indicate that there had been very little movement of ^{90}Sr during the 2-yr period, taking into account the fallout measurements that also had been made in this interval. Some of the physicochemical factors that may affect movement of ^{90}Sr in soils are discussed. (BBB)

3189 BULLETIN OF THE ATMOSPHERIC RADIOACTIVITY, NO. 42, JULY–SEPTEMBER, 1965. Taiki Hoshano Kansoku Seiseki, No. 42, 1-61(July-Sept. 1965).

Data are tabulated on temporary standard sample (U_3O_8) measurements, radioactivity of rain samples, and radioactivity of airborne dusts in Japan during the period July through September, 1965. (R.C.K.)

3190 EVIDENCE FOR BOMB-PRODUCED ^{32}Si. Dansgaard, W. (Univ. of Copenhagen); Clausen, H. B.; Aarkrog, A. J. Geophys. Res., 71: 5474-7(Nov. 15, 1966).

Silicon-32 in the atmosphere is normally produced by cosmic-ray-induced spallation of argon. Production of ^{32}Si by nuclear weapons tests has been considered improbable. Evidence is presented, however, which indicates that artificial formation of ^{32}Si must have taken place because changes in cosmic radiation cannot account for the ^{32}Si variations. It is concluded from air and precipitation measurements of ^{32}Si fallout in recent years that its origin was the nuclear weapons tests in 1961 and 1962. (R.C.K.)

3191 GLOBAL CIRCULATION OF NUCLEAR DEBRIS FROM THE MAY 14, 1965, NUCLEAR EXPLOSION. Cooper, W. W.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). Contract AT-(40-1)-2529. J. Geophys. Res., 71: 5471-3(Nov. 15, 1966). (ORO–2529-2).

Measurement of the strontium-89 and -90 contents in rain water at Tokyo, Japan, and Fayetteville, Arkansas, indicate that debris from the Chinese nuclear device exploded on May 14, 1965, traveled around the world in less than a month. (F.S.)

Mineralogy

3192 (SC-RR–66-548) ADDITIONAL HUGONIOT DATA FOR GEOLOGIC MATERIALS. Bass, Robert C. (Sandia Corp., Albuquerque, N. Mex.). Oct. 1966. Contract AT(29-1)-789. 29p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Hugoniot equation-of-state data were obtained for several additional geologic materials. Included were andesite, volcanic breccia, granite, limestone, oil shale, tuff, and alluvium. (auth)

3193 RADIOGENIC Kr AND Xe ISOTOPES IN URANINITES OF NORTHERN KARELIA. Shukolyukov, Yu. A.; Tolstikhin, I. N. (Lab. for Precambrian Geology, Academy of Sciences, USSR). Geokhimiya, No. 10, 1175-82(Oct. 1966). (In Russian).

Variations of Kr and Xe isotopic composition in 5 samples of uraninites of Northern Karelia are due to different contributions of the neutron-induced fission of ^{235}U. The apparent ages of the uraninites estimated according to He, Kr and Xe contents are too low in comparison with the data of the Pb–method owing to the migration of radiogenic gases. A model of continuous gas losses is suggested; the rate of losses is proportional to the gas quantity. The age of $(1.91 \pm 0.12) \times 10^9$ years evaluated according to this model is in good agreement with the data obtained by the Pb and U–Xe methods for monazite. (auth)

3194 USE OF THE METHODS OF QUANTITATIVE MICROAUTORADIOGRAPHY IN GEOCHEMISTRY. Polyakov, A. I.; Korobkov, V. I. (Vernadsky Inst. of Geochemistry and Analytical Chemistry, Moscow. Moscow State Univ.). Geokhimiya, No. 10, 1222-7(Oct. 1966). (In Russian).

The Th and U content has been separately determined in rocks, rock-forming and accessory minerals by the microautoradiographic method using the liquid nuclear emulsion A-2. A comparison of the results obtained with data of chemical analysis is given. It is proposed to determine the Th/U ratio according to the correlation of horizontal projections of the longest tracks of α-particles emitted by the ThC′ and RaC′. The sensitivity of the method is $n \times 10^{-5}\%$, the magnitude of the radioactive background is quite negligible. The method allows the determination of the Th and U content in minerals being tightly intergrown and to operate with microgram amounts of matter. (auth)

3195 URANIUM RESOURCES OF JAPAN. THE PRESENT STATE OF PROSPECTING AND DEVELOPMENT, AND THE FUTURE ASPECT. Sato, Motoo (Central Engineering Corp., Japan). Nippon no Kagaku to Gijutsu, 6: No. 12, 6-13(Dec. 1965). (In Japanese).

The total amount of uranium ore deposits in Japan, as of April 1964, is approximately 3.30 million tons, the average uranium content 0.06% U_3O_8, and the total amount of U_3O_8 approximately 2000 tons. This 0.06% is fairly low, compared with the world level of 0.1%, but the ore is of outstanding quality, not comparable with those in other countries, in their mineral composition and other structures. Descriptions are given of the Ningyo-toge uranium deposits and the Tokai Refinery of Japan Atomic Fuel Corporation. Geological features, mineralization, mining, refining, and future aspects are discussed. (NSA of Japan)

3196 ISOTOPIC COMPOSITION OF MAGNESIUM EXTRACTED FROM ROCKS AND LAVAS OF VERY DIFFERENT ORIGINS. Buchs, Armand; Krummenacher, Daniel; Noetzlin, Jacques (Univ., Geneva). Schweiz. Mineral. Petrog. Mitt., 45: 847-53(1965). (In French).

The ratios $^{26}Mg/^{24}Mg$ and $^{25}Mg/^{24}Mg$ were measured by mass spectrometry on a variety of samples to examine the following hypotheses: (1) rocks of different origins and formed under variable conditions of temperature and pressure will show changes in isotopic composition; (2) the differences of isotopic composition between dolomites and lavas might indicate the origin of amphibolites; and (3) lavas of different origin and magmatic history might show minor variations of magnesium isotopic composition. To investigate the validity of these concepts, 22 isotopic determinations of magnesium were done on minerals, rocks, and lavas of very different origins. These measurements did not show any isotopic fractionation for rocks of the major cycle, except perhaps for minerals formed by hydrothermal processes and for carnallite, which shows a definite enrichment in ^{24}Mg. For the rocks without isotopic fractionation the mean values of 0.140 ± 0.007 and 0.127 ± 0.007 were found for the $^{26}Mg/^{24}Mg$ and $^{25}Mg/^{24}Mg$ ratios, respectively. The samples tested had been collected from Japan, New Zealand, Hawaii, Tahiti, Philippines, Germany, and Switzerland. (BBB)

3197 DETERMINATION OF THE RADIOACTIVITY DISTRIBUTION IN GRANITIC ROCK OF THE BROCKENMASSIF (HARZ) BY THE NUCLEAR EMULSION METHOD. Henning, K. H. (Univ., Greifswald, Ger.). Chem. Erde, 24: 230-43(1965). (In German).

The radioactivity, particularly α-particle emission, of minerals in granites was investigated by the nuclear emulsion technique. The localization and mineral source of the activity was ascertained, and quantitative measurements were made. The micropegmatite granite investigated had a sp act. of 2.2×10^{-4} α particles/cm^2-sec. The biotite schist contained higher levels (up to 9.3×10^{-4} α/cm^2-sec), while granular inclusions showed the lowest radioactivity (1.6×10^{-4} α/cm^2 sec). Thus sp act. rose with increasing content of biotite, as a result of highly active inclusions, especially of zircon, in the biotite. The accessory zircon, orthite, and monazite, in spite of their low concentration in the rock, made up more than 90% of the radioactive components. Apatite and a small percentage of zircon were inactive. Secondary decomposition and endometasomatic processes caused a decrease in the radioactivity of some specimens. The relatively high specific activity of the biotite schist is an indication of differentiation during genesis of these rocks, while the low radioactivity of finely granular inclusions together with their petrographic specificity indicate their sedimentary origin. (BBB)

3198 GEOLOGIYA GIDROTERMAL'NYKH URANOVYKH MESTOROZHDENII. (Geology of Hydrothermal Uranium Deposits). Shcherbakov, D. I. Moscow, Izdatel'stvo Nauka, 1966. 444p.

Eleven articles are included on the geology of hydrothermal uranium deposits. The articles review the importance of various genetic-type uranium deposits, geological distribution of hydrothermal uranium ore fields in uranium bearing regions, the role of magmatic processes in the formation of hydrothermal uranium deposits, the basic geological characteristics and structure of hydrothermal uranium ore bodies, and the characteristics of the rock surrounding hydrothermal uranium deposits. Mineralogic composition of hydrothermal uranium deposits at various structural levels, and mineral geochemical peculiarities of formation processes of uranium pitchblende are discussed as well as the ratio of hydrothermal uranium mineralization and the endogeneous mineralization of other metals in ore bearing fields. Extensive bibliographies are included. (R.V.J.)

Oceanography

Refer also to abstract 2952.

3199 MANGANESE NODULES: ^{230}Th: ^{231}Pa RATIOS. Sackett, William M. (Univ. of Tulsa, Okla.). Science, 154: 646-7(Nov. 4, 1966).

The $^{230}Th/^{231}Pa$ activity ratio in 7 of 11 manganese nodules is less than 10.8, the theoretical production ratio of activities in the ocean. This finding indicates differential accumulation of these nuclides in authigenic deposits of manganese–iron oxide. (auth)

Seismology

Refer also to abstract 3200.

ENGINEERING

Nuclear Explosions

3200 (PNE-800F) STRONG-MOTION AND SURFACE ACCELERATIONS. Project HANDCAR. Mickey, W. V.; Lowrie, L. M. (Coast and Geodetic Survey, Washington, D. C.). Nov. 1965. Contract W-7405-eng-48. 75p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The 10 kt nuclear detonation, HANDCAR, in dolomite produced larger motions at seismic stations on deep alluvial deposits than those on hard rock with the larger magnifications observed on the horizontal radial component. Regression equations for maximum signal attenuation with distance indicated greater rate of attenuation for stations on hard rock as compared to stations on alluvium. First arrival velocities for stations beyond 2 km were near 5.26 km/sec with maximum displacements propagating at 1.09 and 1.66 km/sec on alluvium and hard rock, respectively, with 2.03 and 2.75 km/sec for maximum acceleration. The record length on the alluvial stations was about twice as long as those on hard rock. The direction of the resultant for horizontal first motion was normal to bedrock–alluvium contacts. Spectral analysis indicated lower frequencies for alluvial stations and a decrease of mean frequency with increased distance. Spectral amplitude ratios of equidistant stations on rock and alluvium emphasized the lower frequency content of the stations on alluvium. Pseudo–velocity response spectra envelopes indicated that more seismic energy was recorded at stations on deep alluvium than those on hard rock. (auth)

3201 (SC-RR-66-416) A SMALL-SCALE INVESTIGATION OF EXCAVATION WITH PARALLEL ROWS OF EXPLOSIONS. PART II. Vortman, L. J. (Sandia Corp., Albuquerque, N. Mex.). Oct. 1966. Contract AT(29-1)-789. 50p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An earlier experiment, in which craters were made by simultaneously detonating parallel rows of charges, was continued using smaller spacing between charges in the rows and between the rows themselves, together with greater burial depth, in a effort to achieve a more effective use of explosive in terms of apparent crater volume per unit of energy than had been observed for three similar rows detonated separately. Although an increase in volume per unit of energy over the simultaneously detonated rows of charges was observed, the cratering effectiveness of three rows separately detonated was not achieved. Permanent vertical and horizontal displacement of the surface near the crater edge could not be correlated with any of the more obvious variables. Patterns of ejecta from the explosion seemed unrelated to charge spacing or burial depth, but displayed an azimuthal relationship about the multiple rows similar to that observed for single rows. When two rows of charges were detonated simultaneously, there was no notable difference between craters formed when the charges in one row were directly opposite those in the other row, and where the charges in one row were offset one-half space from those in the other. (auth)

Facilities and Equipment

Refer also to abstracts 3234, 3466, and 3767.

3202 (ORNL-TM-1616) SPECULATIVE ANALYSIS OF COST OF HEAT FROM VAPOR COMPRESSOR RELATIVE TO COST AS EXHAUST STEAM FROM BACK-PRESSURE TURBINE. Burwell, C. C. (Oak Ridge National Lab., Tenn.). Mar. 25, 1966. Contract W-7405-eng-26. 15p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

An analytical expression that relates the cost of back-pressure turbine exhaust steam to the cost of throttle steam is used to develop a relationship between the cost of heat at the discharge of a vapor compressor and the cost of heat as turbine exhaust steam. The relationship is used to compute vapor compressor to turbine exhaust heat cost ratios for several compressor suction temperatures and compression ratios as a function of prime steam cost. An example of the use of the method in predicting the performance ratio of a water-only plant using a vapor compressor evaporator is presented. (auth)

3203 LAMINAR FLOW AIR HOOD APPARATUS. Whitfield, W. J. (to U. S. Atomic Energy Commission). U. S. Patent 3,273,323. Sept. 20, 1966.

A laminar flow air hood apparatus which may be used for isolating workers from toxic substances being worked on is described. The air hood includes sub-micron filters for removing undesirable particles such as radioactive materials, fluids, or other contaminants from the air laminarly flowing through the working chamber of the air hood. The apparatus includes separate blower systems for drawing air into, and for exhausting air out of the device. Adjustments may be made to provide a balanced air flow condition or air inflow or outflow conditions. (AEC)

3204 ANTI-SIMMER DEVICE FOR RELIEF VALVES. Dunlop, Donald P.; Cousins, Raymond W. (to Atomic Energy of Canada Ltd.). U. S. Patent 3,272,226. Sept. 13, 1966. Filed July 10, 1964.

An anti-simmer device to be used with a relief valve in a pressurized system is described. The device includes a latch to keep the relief valve in a closed position and a means which is responsive to system pressure, to release the latch and allow the relief valve to open for blow-off with a minimum of simmering. When the system pressure falls below a predetermined value, the latch is again positioned to keep the valve closed. (F.S.)

Heat Transfer and Fluid Flow

Refer also to abstract 3223.

3205 (AEEW-R-500) NEW CORRELATION OF NON-UNIFORMLY HEATED ROUND TUBE BURNOUT DATA. Kirby, G. J. (Atomic Energy Establishment, Winfrith (England)). July 1966. 46p. BIS $1.40, HMSO 7s. 0d.

A new correlation of nonuniformly heated round tube burnout data is presented. This fits the available data better than any previously published correlation—the root-mean-square deviation being 5.7% for all data at 1000 psia and the worst fit being for data at 2000 psia where the rms error is 6.6%. The correlation is used to investigate the effect of flux profile changes; no significant increase in burnout power is obtained by modifying the present chopped cosine distribution. (auth)

3206 (BNWL-262) HEAT TRANSFER FROM SOLIDIFIED WASTES IN UNDERGROUND STORAGE TANKS. Willingham, W. E.; Jansen, G. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 1966. Contract AT(45-1)-1830. 75p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Steady state temperature distributions in and around buried radioactive waste storage tanks have been calculated for solidified cakes containing heat-generating fission products. The most important factors influencing the maximum cake and wall temperatures were the quantity of heat generated, the soil thermal conductivity, and the soil cover depth with the heat transfer conditions inside the tank of secondary importance. (auth)

3207 (CEA-R-3039) CODE CACTUS. Fajeau, Maurice; Nguyen Luong Than; Saunier, Jean-Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Sept. 1966. 99p. In French. Dep. mn.

This code handles the following problems: (1) Analysis of thermal experiments on a water loop at high or low pressure; steady state or transient behavior; (2) Analysis of thermal and hydrodynamic behavior of water-cooled and moderated reactors, at either high or low pressure, with boiling permitted; fuel elements are assumed to be flat plates. Flowrate in parallel channels coupled or not by conduction across plates, with conditions of pressure drops or flowrate, variable or not with respect to time is given. The power can be coupled to reactor kinetics calculation or supplied by the code user. The code, containing a schematic representation of safety rod behavior, is a one dimensional, multi-channel code, and has as its complement FLID, a one-channel, two-dimensional code. (auth)

3208 (EURAEC-1359) HEAT TRANSFER CRISIS WITH STEAM-WATER MIXTURES IN COMPLEX GEOMETRIES: EXPERIMENTAL DATA IN ANNULI AND CLUSTERS. Adorni, N.; Gaspari, G. P.; Germani, G.; Peterlongo, G.; Ravetta, R.; Zavattarelli, R. (Centro Informazioni Studi Esperienze, Milan (Italy)). Dec. 1964. Contracts 060-61-7-RDI; 056-62-1-RDI. 68p. (CISE-R-123; EUR-2334). Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

All the heat transfer crisis and pressure drop data for upward flow of steam–water mixtures in test elements having a complex geometry (annuli: 360 points; clusters: 280 points) obtained under CAN-2 and CAN-3 programs are presented. Tests were performed both without spacers, and with different spacer arrangements. The

range of variables is: geometry, annuli (diameters: 1.0/1.5 cm and 1.5/2.5 cm), 3-rod cluster (diameters: rods 0.5 cm, tube 1.5 cm), 7-rod clusters (diameters: rods 1.0 cm, tube 4.6 cm); heated length, 40 to 160 cm; pressure, 50 to 90 kg/cm^2; specific mass flowrate, 80 to 380 g/cm^2 sec; and inlet steam quality, −0.3 to 0.8. Only a short description of results is given, and the influence of spacer arrangement is discussed. (auth)

3209 (GEAP-5278) TRANSITION BOILING HEAT TRANSFER PROGRAM. Fifteenth Quarterly Progress Report, July–September 1966. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Oct. 1, 1966. Contract AT(04-3)-189. 18p. (EURAEC-1739). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed Under United States–Euratom Joint Research and Development Program.

A new test section has been designed to obtain film boiling heat transfer measurements for flow inside a heated tube. Two types of probes for measurement of the steam phase superheat level will be used with the test section: a temperature probe utilizing separation of the moisture from the steam, and a Pitot tube from which the steam temperature can be inferred. Fabrication of the test assembly has been started. (auth)

3210 (KAPL-M-6585) PHOTOELASTIC ANALYSIS OF DIVIDER-LANE THERMAL-STRESSES IN STEAM-GENERATOR TUBE-SHEETS. Slot, T. (General Electric Co., Schenectady, N. Y. Advanced Technology Labs.). Apr. 1964. Contract W-31-109-eng-52. 72p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A three dimensional photoelastic study is reported in which the thermal stresses in a tube sheet due to a linear temperature gradient across the divider lane were investigated. Results are presented for two tube-sheet geometries, each with an equilateral triangular hole pattern. The patterns have the same ligament efficiency of 0.33, but they are oriented differently relative to the divider lane. (auth)

3211 (LA-3585) HEAT PIPE CAPABILITY EXPERIMENTS. Kemme, J. E. (Los Alamos Scientific Lab., N. Mex.). Aug. 22, 1966. Contract W-7405-eng-36. 32p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Axial heat transfer limits were determined for several heat pipe systems having the same outside dimensions, but different wick configurations. Measurements were made at temperatures from 450 to 850°C by using potassium and sodium as working fluids. The wicks consisted of many axial channels, evenly spaced around the inside circumference of each container tube. Different size channels were studied and, in some tests, a layer of fine screen was used to cover the channels and separate them from the vapor passage. The experiments were chosen to show some possible methods for wick improvement and to check the validity of existing heat pipe equations. At higher test temperatures, good agreement was obtained between measured and calculated heat transfer limits. At low temperatures, however, heat transfer capability was below that predicted by theory, and startup difficulties were encountered with the open-channel systems. These problems appear due to an interaction between low-density, high-velocity vapor and returning liquid. The screen covering helped startup and substantially increased heat transfer capability at all operating temperatures. (auth)

3212 (UCRL-7960(Rev.2)) A FINITE DIFFERENCE REPRESENTATION AND SOLUTION OF PRACTICAL HEAT-TRANSFER PROBLEMS. Mintz, Michael D. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 3, 1965. Contract W-7405-eng-48. 51p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A general procedure is presented for the numerical analysis of practical heat transfer problems of virtually any degree of complexity. The processes of conduction, convection, radiation, internal heat generation, and transient heat energy storage and mass transfer are considered. Material properties are assumed to be arbitrary functions of temperature. It is intended that the actual numerical calculations will be performed by a digital computer with suitable subroutines for solving sets of simultaneous linear equations. The simplicity of applying these methods is demonstrated by a discussion of the analysis of simple phase–change cooling processes and a straightforward sample problem; the analyses of a rotating spherical shell in the field of a plane wave radiation energy flux. The basis for numerous digital computer codes employed in the design and analysis of the Tory II–C nuclear ramjet engine (Project Pluto) is described. Use of these codes resulted in a considerable savings in component design time and the elimination of needless, overly conservative safety margins. (auth)

3213 CONTRIBUTION TO THE RESEARCH OF WETTING, FORMATION OF BUBBLES AND VOID FRACTION IN LIQUID METALS. Spiller, K.-H.; Perschke, D.; Gross, G. (EURATOM, Ispra, Italy). Atomkernenergie, 11: 447-46(1966). (In German).

Research on the wetting and formation of bubbles and void fraction measurement in liquid metals in electrically conducting containers and tubes is described. The method is based on measuring the electrical resistance of the container and liquid metal. The complete wetting of stainless steel by liquid Na occurs only at temperatures above 290°C. Bubbles caused by boiling are detected easier on wall surfaces than in bulk. The void fraction of liquid metals may also be measured by the electrical resistance method. (F.S.)

3214 TEPLOVAYA IZOLYATSIYA V TEKHNIKE NIZKIKH TEMPERATUR. (Thermal Insulation in Low-Temperature Engineering). Kaganer, Mikhail Grigorenich. Moscow, Mashinostroenie, 1966. 275p.

A survey of the types and uses of thermal insulation in low-temperature engineering from published sources in the Soviet Union and foreign literature is presented. The various types of insulation materials and vacuum–insulation types used in low-temperature engineering, including graphs and tables of experimental data are presented. The design of low-temperature equipment such as tanks for liquid oxygen and hydrogen, tank trucks for transporting liquid oxygen, and liquid oxygen storage tanks is discussed. (JPRS)

Isotope Technology

Refer also to abstracts 3181 and 3331.

3215 (BNWL-310) AN EVALUATION OF THE PROSPECTS FOR LARGE-SCALE PRODUCTION OF ^{147}Pm. McKee, R. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1966. Contract AT(45-1)-1830. 54p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Potential requirements for ^{147}Pm as a heat source isotope are reviewed. These requirements are compared with estimated availability of ^{147}Pm as a recovered fission-product both from the proposed Isochem Inc. FPCE Plant and from future power reactor spent fuel processing. The economic feasibility of producing additional ^{147}Pm by irradiation of ^{146}Nd is also evaluated and found to be unattractive if ^{147}Pm pricing must be competitive with ^{238}Pu pricing. (auth)

3216 (DP-1051(Rev.1)) PROPERTIES OF ^{60}Co AND COBALT METAL FUEL FORMS. Windley, William C. Jr. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Oct. 1966. Contract AT(07-2)-1. 23p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A compilation of the properties of ^{60}Co and cobalt metal, including information on the compatibility of cobalt with possible encapsulating materials is presented. (R.C.K.)

3217 ISOTOPE THERMOTRANSPORT IN LIQUID POTASSIUM, RUBIDIUM, AND GALLIUM. Lodding, A.; Ott, A. (Chalmers Univ. of Tech., Goethenburg, Sweden). Z. Naturforsch., 21a: 1344-7(Sept. 1966).

Temperature differences ranging from 100 to 500°C were maintained between the top and bottom ends of vertical capillaries containing liquid metal. The light isotope was found to be enriched at the hot end. The steady-state isotope separation for different temperature ranges was between 1 and 3‰, corresponding to the thermal diffusion factors $\alpha_K = 3.1 \times 10^{-2}$, $\alpha_{Rb} = 3.1 \times 10^{-2}$, and $\alpha_{Ga} = 3.8 \times 10^{-2}$. According to a theoretical model, the results imply that the diffusing species is a "cluster" of several cooperating atoms, the mean diffusive displacement of which is considerably less than the effective cluster diameter. The clusters drift into voids given by the statistical fluctuations of free volume. (auth)

3218 THERMAL DIFFUSION OF ISOTOPES IN PURE LIQUIDS. Lodding, A. (Chalmers Univ. of Tech., Gothenburg, Sweden). Z. Naturforsch., 21a: 1348-51(Sept. 1966).

A theoretical treatment is given of the recently discovered thermotransport effect in pure liquid metals. The isotope effect is related to the diffusive mass flow by a proportionality factor familiar from electrotransport. The mass flow is given primarily by the temperature dependence of the mean size or amount of density fluctuations in the liquid. Very little activation energy is required for diffusive motion, which takes place by cooperative position adjustments of neighbor atoms. The mean displacement length of the diffusing cluster is by an order of magnitude smaller than the effective cluster diameter. The liquid model suggested is coherent with models based on evidence from other experimental methods. (auth)

3219 PREPARATION OF THICK ISOTOPIC TARGETS INSIDE AN ELECTROMAGNETIC ISOTOPE SEPARATOR. Formann, E.; Viehboeck, F. P. (Oesterreichische Studiengesellschaft fuer Atomenergie, Vienna). Nucl. Instrum. Methods, 42: 331-2(July 1966).

The method of preparing pure isotopic targets of several mg/cm² with the high dispersion Seibersdorf inhomogeneous magnetic field isotope separator by the sputtering method is described. (B.G.D.)

3220 ECONOMICS OF THE INDUSTRIAL APPLICATION OF ISOTOPES IN HUNGARY AND ELSEWHERE. Abelovszky, Laszlo. Atomtech. Tajek., 9: 181-90(1966). (In Hungarian).

Data have been collected for the last 3 years at the IAEA to provide a clear picture on the business aspects of the industrial application of isotopes. In view of the centralized control over the supply of isotopes in most countries, the purely technical questions were satisfactorily answered, but the economic and business side of the problem was treated in a cursory manner. The level of use of isotopic techniques appears to be directly related to the degree of technical development and sophistication of the country in question. This study was used, together with pertinent Polish and Soviet reports, to compare the application of isotopes in Hungary to that of the more strongly industrialized countries. The chief difficulty lay in the absence of a general reference money for the Eastern European countries; because of the lack of convertibility, the U. S. dollar was used for comparison. Savings arising from the use of isotopic materials and techniques were estimated in the following areas: measurement technology, flow detection, ionization (radiation technology) and tracer techniques. Current research seems to be concentrated in the fields of nuclear geophysics, automatic materials testing devices and the use of large radiation sources. (Review article, 3 tabulations). (TTT)

3221 ADVANCES IN THE PRODUCTION OF RADIOACTIVE LUMINESCENT PAINTS. Wahl, Reinhold. Z. Instrumentenk, 71: 130-3(May 1963). (In German).

A measurable proportion of the background radiation of the population may originate from luminous watch dials bearing radium. Developments in luminous paint now make it possible to eliminate γ radiation exposure from this source. A review of progress in this field shows that in the production of luminescent paints, other materials with induced radioactivity can be used instead of radium. At present, the β rays of promethium-147 and tritium can be successfully used for the activation. Besides the advantage of the dose of radiation being smaller, the β rays destroy the light centers stimulating the luminescence much less than the α rays used until now. Therefore, a higher light intensity can be produced. On the basis of energy, half-life period, time it remains in the body, extent of dose, and other qualities, tritium offers favorable properties for activation of luminous paints, especially as compared with radium. (BBB)

3222 APPARATUS FOR THE SEPARATION OF GASEOUS ISOTOPES. Dobner, Walter. U. S. Patent 3,277,637. Oct. 11, 1966. Filed June 22, 1961.

An apparatus utilizing the molecular velocity of isotopes for the separation of gaseous isotopes is described. The isotopes are separated into isotope traps shaped like grooves, the length and width of which are determined by the product of the ratio of the velocity imparted to the isotopes. The traps are contained in a rotatable cylinder which is rotated at a speed such that light isotopes can pass through the groove into a collector. In several sequences all isotopes are collected. High pressure is imparted to the gas, containing the isotopes to be separated, increasing output and reducing operating expense. (F.S.)

3223 RADIOISOTOPE HEATED THERMOELECTRIC GENERATOR POWER FLATTENING SYSTEM. Rush, R. E. (to U. S. Atomic Energy Commission). U. S. Patent 3,272,658. Sept. 13, 1966.

A power flattening system for radioisotope heated thermoelectric generators is described. Ejectable radiators are provided, which initially reject excess heat generated by the radioisotope heat source. Subsequent to the decrease in the heat output of the source due to its radionuclide decay, the radiators are ejected whereby the heat input from the source to the generator is adjusted to provide a power flattened thermoelectrical generator output. (AEC)

3224 ION-PRODUCING MECHANISMS FOR CALUTRONS. Veach, A. M.; Yonts, O. C. (to U. S. Atomic Energy Commission). U. S. Patent 3,272,983. Sept. 13, 1966.

An ion-producing mechanism for use in a calutron, which is formed in a single, unitized structure with the oven section and the arc chamber section combined into one composite enclosure with a vapor passageway between these sections is described. A perforated baffle divides the arc chamber into a vapor manifold region and an ionizing region. A heated baffle in the ionizing region directs the feed vapor into an electron beam directly behind the ion exit slit. A bottom-vented chamber communicates directly with the ionizing region for withdrawal of un-ionized feed vapor therefrom which eliminates high pressure in the source accelerating region and prevents deposition of un-ionized material on the face and electrodes of the ion source. (AEC)

Materials Testing

Refer also to abstract 3327.

3225 (AWRE-O-82/66) LOADS TO DEFORM ELASTOMER O SEALS (TOROIDAL SEALING RINGS) IN GROOVES AND BETWEEN PLAIN FLANGES. (Atomic Weapons Research Establishment, Aldermaston (England)). Oct. 1966. 27p. Dep. BIS $0,80. HMSO 4s.

The loads necessary to deform O seals in various types of grooves and between plain flanges have not been extensively investigated. As there is a recurrent demand for this information, a series of practical tests was carried out. The results of 210 tests are presented on a nomogram. (auth)

3226 THE RKM-1 VACUUM FOCUSSING X-RAY CAMERA-MONOCHROMATOR. Vestn. Akad. Nauk SSSR, No. 7, 23(July 1966). (In Russian).

A camera for taking x-ray photographs in a vacuum of substances with complex chemical composition and structure was developed. Because of the previous monochromatization of the emission, fogs are avoided and clear x-ray photographs are obtained. An additional reduction of background, particularly in the long-wave region, is achieved by evacuating the working space of the camera. A high resolving power of the diffraction pattern and extreme measurement accuracy of diffraction lines are guaranteed by focussing the beam on a comparatively large cassette diameter (114.59 mm). For this diameter, one millimeter of scan on the x-ray photograph corresponds to a central angle of one degree. The monochromator is a quartz crystal which can be rotated on its axis. The working pressure in the camera does not exceed 10^{-4} millimeters of mercury; the working interval of exposures are: 1.54 angstroms for Cu, 2.23 angstroms for Cr, and 1.94 angstroms of Fe; the area of image focus varies from 3 to 47 degrees. A photograph of the device is included. (JPRS)

3227 MASKING SUBSTANCES FOR NON-DESTRUCTIVE TESTING. Morimoto, Kanichi (to Asahi Glass Co., Ltd.). Japanese Patent 1965-18200. Aug. 17, 1965. Filed Dec. 14, 1963.

Masking substances are proposed, which can be suitably used for the nondestructive testing with x or γ rays of industrial materials, welds, and interiors of cast iron. These include the following: (1) Aqueous solution of an iodide of at least one metal species, selected from alkali metals (including ammonium), alkaline earth metals (including magnesium), zinc, cadmium, indium, iron, cobalt, and nickel metal. (2) Aqueous solution of an iodide of at least one metal species, selected from zinc, cadmium, and mercury iodide, and of an iodide of at least one metal species, selected from alkali metals and alkaline earth metals. (3) Solution of ester, ketone, or aldehyde in which an iodide of one metal species, selected from zinc, cadmium, and mercury, and selected from alkali metals and alkaline-earth metals are dissolved. (4) Solution of acrylic unsaturated fatty acid ester partly polymerized, in which an iodide of at least one metal species, selected from zinc, cadmium, and mercury, and selected from alkali metals and alkaline-earth metals are dissolved. (5) Solution of methylene iodide, or of methylene iodide diluted with solvent such as hydrocarbon or halogenated hydrocarbon. (6) Neutral, acidic or alkaline solution of a salt of a heavy metal such as bismuth, lead, mercury, or barium. The masking substance used for nondestructive testing is prepared by filling solid particles and a radiation-shielding liquid in a flexible sack or bag made of rubber or plastic; the substance has a shielding power nearly the same as the material to be tested. (NSA of Japan)

Protective Structures

3228 (AD-632964) FRICTION LOSS IN FLEXIBLE PLASTIC AIR DUCT. Final Report. Neveril, Robert B.; Behls, Herman F. (General American Transportation Corp., Niles, Ill. General American Research Div.). Oct. 1965. Contract B-70925 (4949A-28). 72p. (GARD-1278-2). CFSTI $3.00 cy, $0.75 mn.

Tests were conducted to determine the pressure drop characteristics of 20-inch diameter, 4-mil thick, polyethylene tubing and both factory and shelter fabricated 90-degree elbows. The tests were performed at flow rates ranging from 1300 to 4100 cfm. These plastic components are part of a portable ventilation system that was developed for Civil Defense fallout shelters. Fully inflated 20-inch diameter plastic tubing has about three-quarters of the pressure drop of sheet-metal duct. However, the last fifty feet of a plastic duct system, which is not completely inflated, has $1\frac{1}{2}$ to 3 times the pressure drop per foot of fully inflated plastic tubing. The result is that for duct systems over 100 feet long the pressure drops for sheet-metal and plastic tubing are approxi-

mately the same. The friction losses for both factory fabricated and shelter fabricated elbows were established. A 40-inch, smooth radius, 90-degree factory fabricated elbow is recommended for use with the Civil Defense Package Ventilation Kit. This elbow develops a pressure drop equivalent to 50 feet of straight tubing. The best shelter fabricated elbow is a three-piece elbow with a radius of 60 inches that can be fabricated from the straight tubing and tape stocked in the Package Ventilation Kit. This elbow develops a pressure drop equivalent to 90 feet of straight tubing. (TAB)

Radioactive Material Handling

Refer also to abstracts 3203 and 3206.

3229 (BNWL–306) FIXATION OF RADIOACTIVE RESIDUES. Research and Development Activities Quarterly Progress Report, April–June 1966. Platt, A. M. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1966. Contract AT(45-1)-1830. 31p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Lithium, boron, and lead were investigated as melting point depressants in processing PW-1 phosphate melts. None were found to be more effective than the presently used sodium. In an investigation of the flexibility of the spray calciner melter flow sheet for processing PW-2, variations of ±15% in the concentration of principal components could be tolerated without adverse effect on stickpoint, melting point, or melt homogeneity but sulfate retention could be effected. The results of a statistically designed experiment on the effects of varying five additive components in PW-2 processing, showed that future studies of this type should use more closely spaced compositional levels. A statistically designed study of the mixed phosphate, borate, silicate–single waste system is nearly completed. It is apparent that a large part of the mixed system results in two liquid phases. Some of the lithium-containing solids expand on cooling through certain temperature intervals. In developmental and design verification tests in the prototype spray solidifier, the drying capacity with water feed was 42 liters/hr; a flow sheet for PW-1 feed modified to melt at 880°C was successfully demonstrated; and a flow sheet for PW-2 feed with the prototype solids addition system demonstrated a tendency to scale at the inlet of the (modified developmental) melter as a result of excessive "sparging" of the melt. The Phosphate Glass Process underwent its first design verification test in B Cell of the C-MEL facility. A PW-2 flow sheet was demonstrated using a 12 in. dia mild steel container as the glass receiver. A concurrent scavenging scheme which uses hydrous oxides–ferricyanides has been developed for removal of fission products from a simulated glass melter condensate. Methods for decontaminating nitric acid fractionator condensate are being evaluated. The analyses have been completed on 4 of the 14 simulated ceramic waste samples which were traced with actual high-level waste material. At 1100°C, release rates for ^{137}Cs were found to be about 1%/hr. Fractional releases of less than 10^{-5}/hr were measured for ^{90}Sr and ^{144}Ce. Release rates for ^{106}Ru varied from 2%/hr to less than the detection limits. Three types of devices have been developed and tested for measuring flow in vertical circulators in underground waste tanks. A sluicing mechanism which allows installation of a transfer pump in sludge has been satisfactorily tested. (auth)

3230 (ORNL-P-2537) DISPOSAL OF RADIOACTIVE WASTES IN GEOLOGIC FORMATIONS. Boegly, W. J. Jr.; Parker, F. L.; Struxness, E. G. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 24p. (CONF-660920-9). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 1st International Congress of the 1st International Radiation Protection Assn., Rome, Italy.

Field scale demonstrations have shown that it is possible to safely and economically store high-level solidified wastes in salt formations and intermediate-level wastes in the slightly permeable shales at Oak Ridge. Disposal of low-level liquid wastes in permeable formations has not yet been demonstrated in field scale plants but the concept has been proven on laboratory scale models. (auth)

3231 (ORNL-TM-1312(Vol.4)) STRUCTURAL ANALYSIS OF SHIPPING CASKS. VOL. 4. EQUATIONS FOR DESIGNING TOP CLOSURES OF CASKS. Spaller, A. E. (Oak Ridge National Lab., Tenn.). Nov. 1966. Contract W-7405-eng-26. 40p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Equations for designing top closures of shipping casks that will meet regulations governing the design and performance of casks in which radioactive material is shipped are developed. The three main areas of the closure that require careful design are the gasket or seal, the retaining devices or bolts, and the flanges on the lid and cask. Design data for different types of gaskets are given, equations for determining the bolting arrangement for cask lids are presented, and equations for determining the thicknesses of both round and rectangular flanges for the lid and cask are developed. (auth)

3232 PORT APPARATUS FOR EXTRACTING MATERIALS FROM RADIOACTIVE ENCLOSURES. Skinner, Dewey F. Jr.; Wolf, Thomas W.; Wade, Warren Z. (to U. S. Atomic Energy Commission). U. S. Patent 3,290,502. Dec. 6, 1966.

A sample extractor port including a sleeve mountable in a shielding wall into which an open ended container may be retractably inserted is described. Especially adapted groove structure in the inner wall surfaces of the sleeve and a compliant sleeve insertable and displaceable inwardly provides sealing for the container and wall while providing contamination shielding of the container mouth. (AEC)

3233 RADIOACTIVE WASTE DISPOSAL USING COLEMANITE. Kaser, J. D. (to U. S. Atomic Energy Commission). U. S. Patent 3,272,756. Sept. 13, 1966.

A process is described in which a solution of radioactive fission products in nitric acid is mixed with finely divided colemanite ($2\,CaO \cdot 3B_2O_3 \cdot 5H_2O$) and the slurry is subjected to spray calcination. The colemanite acts as a flux, giving a product which does not stick to the walls of the calciner and which can be melted and cast at a temperature below 1000°C to form a relatively insoluble glassy solid which does not disintegrate in water. (AEC)

3234 ELECTRICAL BILATERAL SERVOMECHANISM. Komai, Kenichiro (to Hitachi Ltd.). Japanese Patent 1965-20605. Sept. 14, 1965. Filed Oct. 1, 1962.

An improved bilateral servomechanism is proposed in which the viscosity resistance is decreased or removed by local-speed feedback, and the field transmission is excellent, removing the usual drawbacks. Provision is made for the separate local-speed feedbacks at the master and slave sides, thereby decreasing or removing the viscosity resistance, a drawback to the conventional devices. When employed in large or high-precision servomanipulators in particular, the fatigue on the side of their operator is reduced considerably, in addition to the improved performance. Differential signals for the positions and speeds of the master and slave sides are fedback to the master and slave sides; also, local-speed feedbacks are given to both sides. The signals, proportional to the speeds obtained from the output windings of the speed dynamos at both sides, are locally fedback separately. The output windings are respectively connected to the transformers; and, the differential-speed signals, obtained by differentially tying the output windings of the transformers, and the differential-position signals for the master and slave sides are fedback to both sides. Two output windings are installed on the speed dynamos at both sides. A signal, proportional to the speed obtained from one of the windings, is separately fedback; and, also, a differential-speed signal, obtained by differentially tying the other winding, and the differential position signals for the master and slave sides are fedback to both the sides. (NSA of Japan)

3235 COMPOSITION AND METHOD FOR FIXING ATOMIC WASTE AND DISPOSAL. Shock, D'Arcy A.; Sudbury, John D.; Gant, Preston L. (to Continental Oil Co.). U. S. Patent 3,274,784. Sept. 27, 1966. Filed Feb. 24, 1961.

An economical method is described for disposing of radioactive waste solutions and slurries in surface and subsurface reservoirs and fractured impermeable rock formations. Waste is mixed with clay minerals to form a slurry similar to drilling mud. The slurry is then converted to a high lime mud which quickly solidifies. The solidifiable material containing radioactive waste is injected into horizontal fractures in impermeable rock formations. Additional solidifiable material free of radioactive waste is then injected into the fracture to seal the waste in the rock formations. (F.S.)

Vacuum Engineering

3236 (AEET–249) STUDY OF THE EFFICIENCY OF A GETTER–ION PUMP. Nambiar, K. B.; Divatia, A. S. (Atomic Energy Establishment, Trombay (India). Nuclear Physics Div.). 1966. 11p. Dep. mn.

Efficiency of a getter-ion pump developed at the Van de Graaff Laboratory was studied. Outgassing of the system, performance of the getter and the distribution of the getter material inside the pump chamber are factors which influence the efficiency. Baking of the pump chamber was found essential for attaining lower ultimate pressures and better pumping efficiency. Various getters were tried in the pump and it was found that titanium is superior to all the others. (auth)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 3115, 3178, 4233, and 4415.

3237 (AEET-259) REFLECTIVITIES OF SOME METALLIC CRYSTALS USED IN NEUTRON SPECTROMETERS. Rao, K. R. (Atomic Energy Establishment, Trombay (India). Nuclear Physics Div.). 1966. 29p. Dep. mn.

Neutron crystal spectrometers make use of several metallic single crystals like aluminum, copper, or lead for providing monochromatic neutron beams or for use as analyzers. The efficiency of several planes of these crystals for such purposes is presented in the reflection and transmission geometries. Tables of absolute and effective reflectivities are given. (auth)

3238 (BMwF-FBK-66-24) SILIZIUM-OBERFLAECHENSPERRSCHICHT-DETEKTOREN, HERSTELLUNG, TESTMETHODEN, EIGENSCHAFTEN UND EINIGE ANWENDUNGEN. (Silicon Surface Barrier Detectors: Fabrication, Test Methods, Properties, and Some Applications). Andersson-Lindstroem, G.; Zausig, B. (Hamburg Univ. (West Germany). I. Institut fuer Experimentalphysik). July 1966. 50p. (In German). Dep. mn.

Investigations were performed on fabrication methods for silicon surface barrier detectors and their correlated properties. The resulting technique currently being applied is presented. The method is based on the use of high resistivity silicon material (10,000 – 30,000 Ωcm). Some special tests and results for several properties are given in detail and examples of applications in nuclear experiments are described. (auth)

3239 (BNL-969) REPORT ON A SPARK CHAMBER READER SYSTEM. Heller, Sidney; Schwender, George (Brookhaven National Lab., Upton, N. Y.). Nov. 1965. Contract AT(30-2)-Gen-16. 21p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A description of a spark chamber reader system available at Brookhaven National Laboratory is reported. A general description of the scanner, giving its salient features and numerical values, is followed by sections detailing the available programs for the system, the user requirements, and the system limitations. The appendix contains a description of a calibration procedure for the digitizer. (auth)

3240 (CERN-66-30) ORGANIZATION OF SPARK CHAMBERS WITH MAGNETOSTRICTIVE READ-OUT. Brautti, G. (European Organization for Nuclear Research, Geneva (Switzerland)). Oct. 6, 1966. 34p. Dep. mn.

The organization of a system of wire spark chambers with magnetostrictive readout is described. Topics discussed are mechanical construction, geometrical and physical problems, electronics, and analog and digital data handling. (B.G.D.)

3241 (CLOR-IBJ-54/D) COSMIC RAY BACKGROUND IN SILICON SPECTROMETER. Jaguszlyn, M.; Przyborski, W.; Roman, J.; Slapa, M. (Centralne Laboratorium Ochrony Radiologicznej, Warsaw (Poland)). 1966. 17p. Dep.

Measurements of the pulse-height distribution and intensity of cosmic ray background in silicon spectrometers are presented for various detector thicknesses. An average count due to cosmic rays was found to be 1.43 ± 0.11 cpm per sq. cm of detector sensitive area. A low-background beta-ray spectrometer was constructed with two silicon detectors operated in anticoincidence. The background count measured in the energy region above 15 keV was less than 0.3 cpm per sq. cm. (auth)

3242 (DP-1059) PLUTONIUM WOUND MONITOR. Splichal, William F. Jr. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Sept. 1966. Contract AT(07-2)-1. 14p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A portable, lightweight monitor was developed to measure plutonium in wounds. Two scintillation detectors were designed for use with this instrument: one detects 17-keV x-rays from plutonium with a minimum detection level of 0.3 nCi of ^{239}Pu under ¼ inch of tissue; the other detector is sensitive to alpha particles and is used to locate plutonium on the skin, in or near the wound. Plug-in circuit cards facilitate repair of the monitor. (auth)

3243 (EGG-1183-2122) FLUORESCENCE EMISSION DETECTOR WITH 100 PICOSECOND TIME RESOLUTION. McGuire, R. L.; Palmer, R. C. (Edgerton, Germeshausen and Grier, Inc., Las Vegas, Nev.). Oct. 21, 1966. Contract AT(29-1)-1183. 15p. (CONF-661020-4). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 13th Annual Nuclear Science Symposium, Boston, Mass.

An emission telescope was developed for studying light intensity vs time of scintillators and Cherenkov radiators in the subnanosecond time domain. Sample excitation is achieved with 10-MeV, 50-picosecond pulses of electrons from the EG&G/AEC linear accelerator. Test samples are viewed by an ultrahigh speed, coaxially mounted vacuum photodiode detector via a 6-inch spherical mirror with an effective aperture of f/1. Photodiode detector output signals are recorded by a sampling scope, computer-of-average-transients data handling system. Overall time resolution of the system is 150 picoseconds (FWHM). The resolution function is obtained from Cherenkov emission in lucite and water. The response of a few typical fast plastic fluor materials are presented, showing the prompt Cherenkov emission followed by the comparably slow fluorescence rise and decay. (auth)

3244 (JINR-P-2916) OPREDELENIE NAPRAVLENIYA PUCHKA NEITRAL'NYKH CHASTITS VYSOKOI ENERGII SINKHROFAZOTRONA OIYAI PO IZUCHENIYU KONVERSIONNYKH PAR I SPEKTR γ-KVANTOV V ETOM PUCHKE. (Determination of the Direction of the Neutral High-Energy Particle Beam of the JINR Synchrophasotron by Conversion Pairs and γ-Quantum Spectrum in This Beam). Beshliu, T.; Vishnevskii, V.; Gavrilash, M.; Konstantinesku, A.; Mikhul, A.; Moroz, V.; Nikitin, A.; Troyan, Yu. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1966. 9p. (In Russian). Dep. mn.

The direction of the JINR synchrophasotron neutral particle beam in the bubble chamber was determined by conversion pairs. The accuracy of the beam axis is determined to be about $0.6 \cdot 10^{-3}$ rad. (auth)

3245 (ORO-2791-19, pp 1-31) INSTRUMENTATION. (Texas Nuclear Corp., Austin).

Developments in instrumentation are discussed including the construction of a low-energy recoil telescope for absolute neutron flux calibration, modification of time-of-flight gating to improve background subtractions, and the use of solid-state Ge(Li) detectors as part of the spectrometer system. Also the design and operation of the Klystron bunching system for increasing the available neutron flux is also described, and a brief outline on the newly installed computer facility is included. (auth)

3246 (PPAD-605E) A MODULAR ELECTRONIC SYSTEM FOR MAGNETOSTRICTIVE SPARK CHAMBERS. Droege, Thomas F. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). Oct. 26, 1966. Contract AT(30-1)-2137. 24p. (CONF-661020-9). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 13th Annual Nuclear Science Symposium, Boston, Mass.

A flexible electronic system is described where each module performs a single function. The system was designed around a digital data buss which allows read-out by typewriter, magnetic tape, computer or combinations of these. Besides those associated directly with magnetostrictive spark chambers the system includes auxiliary modules such as scalars, pulse height to digital converters, event registers, and fixed data input so that all aspects of a particular event can be recorded. Sub modular techniques and integrated circuits reduce the required number of printed circuit boards and facilitate fabrication of special modules. Several operating systems are described. (auth)

3247 (SLAC-PUB-230) TESTS ON SCOTCHLITE PLACED IN A SIMULATED HYDROGEN CHAMBER. Sukiennicki, B.; Barney, H. (Stanford Linear Accelerator Center, Calif.). Oct. 1966. Contract AT(04-3)-400. 12p. (CONF-660918-10). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From International Conference on Instrumentation for High Energy Physics, Stanford, Calif.

The techniques and results obtained with a test program on Scotchlite to establish mounting procedure, optical performance, and selection of the best material available for use in a retrodirective illumination system of a bubble chamber are reported. (B.G.D.)

3248 (UCRL-14926) U-JUNCTION Ge(Li) DRIFT DETECTORS. Armantrout, Guy A. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 15, 1966. Contract W-7405-eng-48. 12p. (CONF-661020-6). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 13th Annual Nuclear Science Symposium, Boston, Mass.

A U-junction drifting configuration was used which permits the fabrication of large volume, low-capacitance detectors in much less time than previously required. For example, it is now possible, with good material, to fabricate in approximately one week an 18-cm^3 diode with 3-pF capacitance. The U-junction structure is partially wrapped around three sides of a parallelepiped of the de-

sired dimensions. The drifting then proceeds toward the remaining side of the detector. At the completion of the drift, only a narrow strip of P-type material remains along one edge. The portion of the lithium junction used for the rapid drift is now lapped off, leaving the low-capacitance junction structure for the collection of the charge. No further processing is required, and the diode is ready for mounting. Initial tests on two 6-cm^3 U-junction detectors indicate that the diodes have the expected capacitance of about 2 pF and a relatively thin window. A resolution of 705 eV for the 60-keV gamma ray of ^{241}Am was thus far obtained, and the measured Fano factor of 0.157 is consistent with the currently accepted value. (auth)

3249 (UCRL-17149) HIGH-RESOLUTION BETA- AND GAMMA-RAY SPECTROMETER. Elad, Emanuel; Nakamura, Michiyuki (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 27, 1966. Contract W-7405-eng-48. 23p. (CONF-661020-10). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 13th Annual Nuclear Science Symposium, Boston, Mass.

A high-resolution semiconductor beta and gamma spectrometer is described. The spectrometer consists of a silicon or germanium detector, low-noise field-effect transistor pre-amplifier, and a linear amplifier. The requirements for the different sections for high-resolution performance are outlined. (B.G.D.)

3250 (UCSB-34P135-1) SPECIAL DETECTOR DEVICES AND ULTRA HIGH SPEED CIRCUITRY. Caldwell, David O. (California Univ., Santa Barbara). Oct. 14, 1966. Contract AT(11-1)-34. 22p. (CONF-660918-11). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From International Conference on Instrumentation for High Energy Physics, Stanford, Calif.

The recent developments in detection equipment for high-energy physics are discussed. Topics included are electronics, photomultipliers (and other photo tubes), Cherenkov counters, and new experimental systems. (B.G.D.)

3251 MAGNETIC NEUTRON COUNTER. Kopvillem, U. Kh.; Khabibullin, B. M. (Kazan Physicotechnical Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 2, 87-91(1966). (In Russian).

Based on numerous studies of Cr^{3+} in Al_2O_3 as the active medium of masers and lasers, a magnetic counter is proposed for recording energy spectra of neutrons and other neutral elementary particles, e.g., neutrinos and antineutrinos. Operation of the proposed counter is based on the conversion of the kinetic energy of a particle flux into quanta $\hbar\omega_{2,1} = E_2 - E_1$ of the potential energy of magnetic particles of the medium in the inner field of the crystal and on the subsequent count of spontaneously emitted photons of frequency $\nu_{2,1}$. General theoretical calculations show that by sufficient lowering of the temperature, any degree of sensitivity of the counter can be achieved. Unlike some other similar elementary particle counters, this device will react to any interaction capable of producing particle transition between levels E_1 and E_2. Generally, such an interaction depends on the pulse direction of the impinging particle and, consequently, can serve as an indicator of the direction of elementary particle fluxes in space. In contrast to counters which utilize nuclear reactions and require a very high initial kinetic energy, this device operates at an initial energy $\geq E_2 - E_1 \sim 100°K$. External noise has little effect on the operation of the device at high frequencies ($\Delta E \geq 100°K$). However, in the microwave and rf regions, the sensitivity threshold of the counter is determined chiefly by this noise. Both weak interactions of elementary particles and neutrinos at 0.025 eV to 1 MeV can be recorded. (ATD)

3252 STUDY OF SCATTERING FACTOR IN NUCLEAR EMULSIONS. Sood, P. M.; Ahuja, S. D. M. (Panjab Univ., Chandigarh, India). pp 657-63 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

Variation of scattering factor K was calculated for standard G-5 nuclear emulsions from a few theories pertaining to multiple Coulomb scatterings. It was also estimated experimentally by the Y-displacement method for cell lengths 4, 6, and 8 cm and by Fowler's coordinate method for cell lengths 4 mm to 4 cm. Results by both the methods agree very well with each other but are lower than the theoretical expectations by about 15 to 25%. (auth)

3253 DETERMINATION OF THE QUALITY FACTOR THROUGH THE UTILIZATION OF A BALANCED, TISSUE EQUIVALENT, IONIZATION CHAMBER. Distenfeld, C. H.; Markoe, A. M. (Brookhaven National Lab., Upton, N. Y.). Nucl. Instrum. Methods, 45: 181-9(1966).

Accelerator dosimetry tends toward either specifying the field by way of its components or using a tissue equivalent chamber with a failsafe Quality Factor (QF). This investigation attempts a third approach, the determination of QF directly. A Lucite, three-parallel plate ionization chamber was constructed with a common center electrode and two independent outer electrodes. This configuration allows the position of the center electrode to be manually adjusted to effect first order balance; vernier balance is obtained electronically through adjustment of one of the paired electrometers. The chamber can be pressurized to at least 17 atm with a tissue equivalent gas mixture and, therefore, approximates tissue rad response. This ionization chamber is capable of detecting differences in LET of any radiation by operating on the principle of columnar recombination. The previous investigators use either a single ion chamber or operate their respective systems in the general recombination mode. This technique requires low polarizing voltages and, therefore, is useful only for low dose rates. Both the single chamber and the general recombination system are limited in accelerator dosimetry applications. Very high instantaneous dose rates and extreme variability of sources dictate a balanced ionization chamber system that utilizes columnar recombination. In the present instrument, one of the chambers is operated at low polarizing potential while the other is variable. The difference current between the two chambers is adjusted to zero for background levels and when sensing radiation this difference current is a measure of QF. In operation, the slope, with voltage, of the difference current is proportional to the QF of the radiation. This proportionality is apparently linear at 10 atm over a range of QF from one to at least 7.5. This response has been shown to be dose-rate independent. The directional dependence and pressure dependence of this chamber have been studied and are reported. (auth)

3254 LARGE AREA FISSION FRAGMENT DETECTOR WITH FAST RESPONSE. Boeckhoff, K. H.; Migneco, E.; Theobald, J.; Wartena, J. (EURATOM, Geel, Belg.). Nucl. Instrum. Methods, 45: 233-7(1966).

The performance of a fission fragment detector is described which can be used for high resolution fission cross section measurements. It consists of two very thin plastic scintillator foils of large areas sandwiching a fissile layer. Coincidence techniques applied to the signals of two photomultipliers which view these scintillators allow to discriminate fission fragments against alphas and other background sources. Amplitude spectra and the dependence of fission detection efficiency from location on the detector surface were studied. As a result of an application of the detector, ^{235}U fission reaction rates are shown in function of neutron time of flight. (auth)

3255 CALIBRATION OF 7,5 x 7,5 cm-NaI(Tl) SOLID CRYSTALS FOR ABSOLUTE COUNTING OF SURFACE-TYPE PREPARATIONS. Mundschenk, H. (Univ., Mainz). Nucl. Instrum. Methods, 45: 261-9(1966). (In German).

The photopeak efficiency and the peak-to-total ratio for a 7.5 × 7.5 cm solid NaI(Tl)-crystal are determined in the range of 0.145 – 1.33 MeV. The disintegration rates of the disc sources used are known by $4\pi\beta$- and $4\pi\beta$-γ-coincidence measurements. The effect of the disc diameter and the distance source-crystal on the photopeak efficiency is studied thoroughly. The data obtained are compared with those of other authors. The evaluation of the photopeak area is performed in a frequency diagram, a special type of probability scale, in which both parts of the Gaussian curve are represented by straight lines. Hence, corrections for the Compton overlap, bremsstrahlung and background can accurately be made. (auth)

3256 GENERALIZATION TO MAGNETIC DISTRIBUTIONS OF REVOLUTION OF A METHOD OF CORRECTION OF POLAR FORMS INTENDED TO ENGENDER A TOPOGRAPHY OF PREDETERMINED GRADIENT. Lucenet, G.; Lafoucriere, J. (Institut de Physique Nucleaire, Lyon). Nucl. Instrum. Methods, 45: 250-4(1966). (In French).

A method is proposed to correct the pole pieces in view to obtain a magnetic distribution with determined gradient, from the real distribution given by the noncorrected pole pieces. In the case of the revolution topographies, specially for the $B = B_0/r^n$ distributions used in magnetic spectrography, this analytical and graphical method is general. It was applied in two particular cases: topography with slight gradient (obtained in the air-gap of a synchrocyclotron) and topography B_0/r necessary to realize a magnetic spectrograph with trochoïdal orbits. (auth)

3257 A 14 MeV NEUTRON TIME-OF-FLIGHT SPECTROMETER. Stewart, D. T. (Glasgow Univ.). Nucl. Instrum. Methods, 45: 341-2(1966).

A 14-MeV neutron time-of-flight spectrometer is described which contains a timing system based on the gated-stop principle and incorporates tunnel diode discriminators. (B.G.D.)

3258 DEVELOPMENT OF FLAT RESPONSE COUNTERS BY ADJOINT TRANSPORT CALCULATIONS. Nakayama, T.

(Japan Atomic Energy Research Inst., Ibaraki-ken); Tatsuta, H.; Ryufuku, H.; Olsen, T. M. Nucl. Instrum. Methods, 45: 343-4 (1966).

Approaches are considered by applying two-dimensional S_N methods. Sensitivity vs neutron energy is controlled by changing source distribution. Optimum geometry of drilled holes follows from adjoint angular flux. (auth)

3259 ACCURATELY DEFINED NEUTRON BEAMS FROM D(d,n)^{3}He AT E/sub d/ equals 50 keV, USING THE ASSOCIATED PARTICLE METHOD. Monier, L. F. C.; Tripard, G. E.; White, B. L. (Univ. of British Columbia, Vancouver). Nucl. Instrum. Methods, 45: 282-6(1966).

Accurately collimated fast neutron beams of small angular width and known absolute intensity and energy were produced by bombarding heavy ice targets with 50-keV deuterons and operating the neutron detector in coincidence with a semiconductor counter detecting the ^{3}He recoil nuclei. The measured beam profile agreed with the theoretically calculated profile. The beam was used to measure the absolute neutron detection efficiency and the scintillation pulse spectrum of a plastic scintillation counter bombarded by 2.55-MeV neutrons. (auth)

3260 OPTIMUM DESIGN OF THIN LARGE AREA SCINTILLATION COUNTERS. Crabb, D. G.; Dean, A. J.; McEwen, J. G.; Ott, R. J. (The Univ., Southampton, Eng.). Nucl. Instrum. Methods, 45: 301-8(1966).

The factors involved in constructing thin scintillation counters with large surface area, to obtain maximum light collection together with uniformity are analyzed. Measurements of the relevant parameters were made and principles for optimum design were formulated. Calculations of efficiency show satisfactory agreement with experiment. Two types of counters were constructed and used successfully to detect relativistic particles. (auth)

3261 ENCAPSULATED LITHIUM DRIFTED GERMANIUM DIODE FOR GAMMA RAY SPECTROMETRY. Gibbons, P. E.; Howes, J. H.; Pyrah, S. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods, 45: 322-4(1966).

The design and performance of an encapsulated Ge (Li) diode gamma spectrometer are discussed with emphasis on the encapsulation method. The spectrum of ^{153}Gd obtained with the diode is presented also. (B.G.D.)

3262 SPECTRAL INFORMATION AND THE EXPERIMENTAL RESOLUTION PROBLEM. Grissom, J. T.; Koehler, D. R.; Gibbs, B. G. (Army Missile Command, Redstone Arsenal, Ala.). Nucl. Instrum. Methods, 45: 190-6(1966).

Two new methods are presented for correcting measured spectral distributions for experimental resolution distortion. These techniques are based on numerical solutions of the integral equation transformation between an ideal distribution and the smeared experimental spectrum. The first technique employs the experimental data in a least squares criterion and the second technique is a modified least squares approach using a priori information to limit the appearance of unrealistic oscillations in the solution. The applicability of the techniques to various types of distributions and the use of the technique with experimental data containing statistical fluctuations are discussed and illustrated with examples. (auth)

3263 GAS SCINTILLATION COUNTER WITH LIGHT AMPLIFICATION EFFECT FOR THE SPECTROMETRY OF LOW-ENERGY CHARGED PARTICLES. Peter, G.; Unholzer, S. (Technische Univ., Dresden). Kernenergie, 9: 260-1(Aug. 1966). (In German).

Light yield of a gas scintillation counter may be increased by applying an electric field. The spectrometric properties of such an ionization chamber with light amplification effect are described. It is shown that the energy resolution is essentially improved by the auxiliary voltage. The signal-to-noise ratio is better than in usual ionization chamber technique. (auth)

3264 FURTHER REMARKS ON THE RELATIONS BETWEEN STATISTICAL MECHANICS AND QUANTUM THEORY OF MEASUREMENT. Daneri, A. (Univ., Pavia, Italy. Applicazioni e Ricerche Scientifiche, S.p.A., Milan); Loinger, A.; Prosperi, G. M. Nuovo Cimento (10), 44B: 119-28(July 11, 1966).

The role played by the concept of metastability of a macrosystem in the quantum theory of measurement is illustrated by discussing the two significant cases of the scintillation counter and of the spark chamber. (auth)

3265 SPHERICAL DOSE EQUIVALENT NEUTRON DETECTOR. Leake, J. W. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods, 45: 151-6(Nov.-Dec. 1966). (AERE-R-4884).

A spherical neutron detector has been designed which is a development of the Andersson and Braun counter, but which weighs only 5 kg. The detector comprises a double polythene moderator system, with a LiI(Eu) crystal at the center, which is viewed by a photomultiplier. The neutron energy response of the detector matches the recommendation of the ICRP (1963) within ±50% for neutron with energies between 200 keV and 10 MeV, the sensitivity falling above 10 MeV. Below 200 keV the sensitivity increases above the required value to a maximum at 5 keV where it overestimates by a factor of $3\frac{1}{2}$ times. At thermal energies the response is high by a factor of $3\frac{1}{4}$ times. (auth)

3266 BEHAVIOR OF THE THRESHOLD CIRCUIT AT THE INPUT OF ANALYSIS SYSTEMS FOR SCINTILLATION PULSES. Abbattista, N. (Istituto di Fisica, Bari, Italy); Coli, M.; Plantamura, V. L. Nucl. Instrum. Methods, 45: 157-65(Nov.-Dec. 1966).

In nuclear physics experiments, errors of timing measurements result from the contribution of disturbances, intrinsic at the electronic counting system. The counting system is affected by the statistical variations of the input pulse shape. The threshold behavior and delay jitter vs input rise time was studied for a tunnel diode basic monostable circuit. Therefore, an operative definition of the threshold is given and its variation for exponential and ramp input shaped pulses calculated. The results are critically tested with experimental circuits. The counting losses are found to be ascribed to the jitter of the input pulses rise time. The results obtained may be straightly applied to all switching circuits in a more general fashion. (auth)

3267 DETERMINATION OF BUBBLE DENSITY. Gluckstern, R. L. (Univ. of Massachusetts, Amherst. Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Nucl. Instrum. Methods, 45: 166-72(Nov.-Dec. 1966).

The extraction of bubble density information from the locations of bubble centers is discussed. The distribution of blob lengths is derived and procedures for simultaneous use of the blob length and gap length distributions are outlined. The effects of possible bubble coalescence, nonuniform bubble diameter, efficiency of scanning devices and variation of the relevant parameters over the field of view are taken into account. Application of these considerations is made to the present development of automatic scanning and measuring devices for bubble chamber film. (auth)

3268 SOME APPLICATIONS OF SEMICONDUCTOR COUNTERS IN HIGH ENERGY PHYSICS. Akimov, Yu. K. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Instrum. Methods, 45: 173-7(Nov.-Dec. 1966).

The small size of semiconductor counters is a considerable limitation for their application to detect high energy particles. However, in experiments on accelerators there is a certain number of special problems where semiconductor counters can be rather effectively used. In particular, good spectrometric properties, nonsensitivity to the magnetic field and the compactness of the semiconductor counter allow to use it for identifying slow protons and deuterons in elastic pp and pd scatterings. In our case the target was bombarded with the 10 GeV internal proton beam of the proton synchrotron of the Joint Institute for Nuclear Research. Semiconductor counters operating in the photodiode regime were applied to measure particle fluxes in other investigations carried out on the synchrocyclotron. Optical characteristics of lithium-drifted silicon counters of the surface-barrier type were studied. Being rather perfect fast photodiodes, the counters can be used also for determination of the spark coordinates in a spark chamber. (auth)

3269 DETERMINATION OF FAST NEUTRON SPECTRA BY USING THRESHOLD DETECTORS. Faehrmann, K. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie, 9: 261-2(Aug. 1966). (In German).

It is shown that the spectral index for the detector pair ^{103}Rh(n,n')$^{103\,m}$Rh and ^{115}In(n,n')$^{115\,m}$In can be reduced to a one parameter approximation that can be used in turn to measure the spectra of fast neutrons. A test measurement of the reaction ^{32}S(n,p)^{32}P is reported. (G.O.Y.)

3270 BETA SPECTROMETER WITH TROCHOIDAL TRAJECTORIES USING IRONLESS COILS. Mugnier, D.; Lafoucriere, J. (Institut de Physique Nucleaires, Lyon). Nucl. Instrum. Methods, 45: 45-58(Nov.-Dec. 1966). (In French).

A β spectrometer with trochoidal trajectories uses a magnetic field of cylindrical symmetry, varying as the inverse of the distance to the axis. A method is presented giving the required form of the field, with an accuracy of 8×10^{-4} in a region, where the lower and upper limits r_1 and r_s satisfy the relation $r_s/r_1 = 3.4$. This method allows an aperture of the beam of 18° or 110° in the plane of symmetry for the respective cases of a radial or tangential emission (the axial aperture can reach 20°). (auth)

3271 SYSTEM OF SONIC SPARK CHAMBERS. Bizard, G.; Duchon, J.; Landaud, G.; Le-Meilleur, F.; Patry, J. P.; Scherer, M.; Seguinot, J.; Yonnet, J. (Univ., Caen, France). Nucl. Instrum. Methods, 45: 119-24(Nov.-Dec. 1966). (In French).

Four sonic spark chambers and their triggering and recording electronics are described. The effective area of the chambers is 50×50 cm^2 for three of them, 80×80 cm^2 for the fourth. In order to estimate the precision of localization a test was made using high energy cosmic rays. (auth)

3272 EFFICIENCY CALIBRATION OF 3" x 3" NaI(Tl) CRYSTALS. Chinaglia, B.; Malvano, R. (SORIN, Saluggia, Italy). Nucl. Instrum. Methods, 45: 125-32(Nov.-Dec. 1966).

Photopeak efficiencies for 3" × 3"NaI(Tl) crystals were determined at different source-detector distances in the energy range 0.02 to 4 MeV with good accuracy (within 2% below 2.8 MeV) and the absorption factor of the detector housing and the distance outer face of the housing-outer face of the crystal were evaluated. The photofraction in the considered energy range was obtained by introducing the experimental results in the general relationship giving the photoelectric efficiency as a function of total efficiency, of total photofraction and of photon absorption in the detector housing; the resulting values are compared with the data reported in the literature. (auth)

3273 SIMULTANEOUS STUDY OF THE REACTIONS (d,t), (d,^{3}He), AND (d,α) WITH A 3 DETECTOR TELESCOPE. Bouche, R.; Feuvrais, L.; Gaillard, M.; Gaillard, P.; Gouanere, M.; Gusakov, M.; Pizzi, J. R.; Sarazin, A.; Vidal, J.-L. (Univ., Lyon). Nucl. Instrum. Methods, 45: 133-7(Nov.-Dec. 1966). (In French).

The system described allows the simultaneous identification of deuterons, tritons, helium-3 and helium-4 particles produced in reactions induced by 28.5-MeV deuterons. This identification is made possible by using three detectors of suitable thickness. The output signals are digitalized and calculations are made off-line with a CAE-510 computer. (auth)

3274 SETUP FOR MEASURING SENSITIVITY–FREQUENCY CHARACTERISTICS OF PHOTODETECTORS. Khaykin, N. Sh. Prib. Tekh. Eksp., No. 3, 172-4(1966). (In Russian).

A method of undesirable-pickup suppression and a setup for measuring sensitivity-frequency characteristics of radiation detectors (photodiodes, photomultipliers) are described. Essentially, the radiation flux modulated by an electrooptical element is once more modulated at $\Omega \geq (2-3)\,\Delta\omega$, where $\Delta\omega$ is the passband width of an analyzer that records the photoresponse of the test detector; the second modulation is accomplished by a mechanical (60-kc) modulator. An experimental setup included a Kerr cell and operated satisfactorily within 1 to 120 Mc. It was used for testing a few photodiodes (1 to 35 Mc) and a photomultiplier (1 to 80 Mc). (JPRS)

3275 ABSOLUTE v/c MEASUREMENTS WITH A β SPECTROMETER. Jahn, P.; Daniel, H. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Z. Naturforsch., 21A: 1184-7(July 1966). (In German).

A method was described that makes it possible to determine absolutely the v/c values or momentum for conversion electrons in units of mc. It is only necessary to measure with high accuracy the pulse ratios of four suitable conversion lines which belong to two parallel γ cascades. The method was applied to the measurement of the decay ^{192}Ir $\rightarrow$ ^{192}Pt and compared with results from other methods. The x-ray term differences of the ^{192}Pt were derived in mc^2 units and compared with literature data. A new method for the determination of the specific charge e/m of the electron was discovered in the inclusion of data on spectrometer geometry and current measurements. The value of $e/m = 1.7594 \pm 0.0004 \times 10^7$ emu was obtained. This accuracy corresponds with the best previous individual measurements. (tr-auth)

3276 A HIGH-RESOLUTION γ SPECTROMETER WITH Ge(Li) DETECTOR AND FIELD-EFFECT TRANSISTOR PREAMPLIFIER. Kalbitzer, S.; Melzer, W.; Kemmer, J.; Walther, P (Max-Planck-Institut fuer Kernphysik, Heidelberg). Z. Naturforsch., 21a: 1178-83(July 1966). (In German).

The preparation of a high-resolution Ge(Li) detector by different drift methods and the diagram of a fast preamplifier with a field-effect transistor in the input stage are described. The radiation of ^{60}Co was resolved with a 3-keV half value width. A value of 0.20 to 0.25 was given for the Fano factor in the energy range from 300 to 2750 keV. (tr-auth)

3277 ON THE FORMATION OF SURFACE BARRIER LAYERS OF SILICON DETECTORS. Bader, R.; Kalbitzer, S. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Z. Naturforsch., 21a: 1072-4(July 1966). (In German).

The processes for the formation of surface barrier layers on n-silicon treated with gold vapor was investigated. The thickness of the gold layer, temperature, and oxygen pressure were varied. The delay time between the moment of oxygen introduction and the formation of the barrier layer was measured in all cases. The activation energy of the oxygen diffusion was 0.85 ± 0.04 ev. The delay time is squarely dependent on the gold layer thickness and also shows a pressure dependence. (tr-auth)

3278 RECENT DEVELOPMENTS IN LIQUID-SCINTILLATION MEASURING TECHNIQUES. Schwerdtel, E. (Frieseke and Hoepfner GmbH, Erlangen, Ger.). Kerntechnik, 8: 517-20 (Nov. 1966). (In German).

Recent developments in liquid scintillation measuring techniques are described with emphasis on the improvements made in efficiency and efficiency determinations, the measurement of pulse spectra, and the discrimination of doubly labeled substances. The operational ease of the liquid scintillation detectors is indicated. (J.S.R.)

3279 A COMPUTER-CONTROLLED 4096-CHANNEL SEMICONDUCTOR DETECTOR SYSTEM WITH STABILIZATION. Swierkowski, Stefan P.; Lafore, Robert W. (Univ. of California, Berkeley). pp. 255-8 of Proceedings of the National Electronics Conference. Vol. XXII. Chicago, National Electronics Conference, Inc., 1966. (UCRL-16814(Rev.)).

The construction and operation of the hardware and software constituting a 4096-channel bistabilized pulse-height analyzer, data processing, and control system are described. The system was designed for studying mesic x-ray spectra at the 184-inch cyclotron. (auth)

3280 MULTIPLE NEUTRON SPATIAL DETECTOR. Johanson, E. W.; Kaiser, W. C. (Argonne National Lab., Ill.). pp 967-71 of Proceedings of the National Electronics Conference. Vol. XXII. Chicago, National Electronics Conference, Inc., 1966.

The development of multiple neutron spatial detector is discussed including preliminary specifications, a list of a group of detectors which might be adapted for multiple neutron detection, and the method to be used to obtain the desired spatial information. (B.G.D.)

3281 SPARK CHAMBER SYSTEM PERFORMANCE. Karambis, G.; Romanowski, T.; Rush, C.; Terandy, J.; Upton, J. (Argonne National Lab., Ill.). pp 972-7 of Proceedings of the National Electronics Conference. Vol. XXII. Chicago, National Electronics Conference, Inc., 1966.

Construction details are presented for thin plate spark chambers ranging in size from 3 in. × 3 in. to 58 in. × 64 in. (plate thickness is 0.8 mil). Included are the techniques for making the plates and the electronics which deliver the high-voltage pulses to the chambers. (B.G.D.)

3282 IRIG COMPATIBLE SPECTROMETER FOR AIRBORNE NUCLEAR PULSE HEIGHT ANALYSIS. Yefsky, Sheldon A. (Illinois Inst. of Tech., Chicago). pp 978-83 of Proceedings of the National Electronics Conference. Vol. XXII. Chicago, National Electronics Conference, Inc., 1966.

A spectrometer system is described which performs the conversion of input information into data formats for transmission as an IRIG FM/FM composite of ten channels. The use of the IRIG system in conjunction with the described pulse height-to-time conversion techniques results in minimizing the airborne equipment cost, weight, and power while achieving 100 channel gamma spectrum resolution and neutron and gamma rate measurements to 10^5 pulses per second. (B.G.D.)

3283 GEIGER COUNTER WITH ANALOG CIRCUITS FOR MEASURING COSMIC MUON MOMENTUM. Allkofer, O. C.; Dau, W. D. (Christian-Albrechts-Univ., Kiel). Z. Angew. Phys., 21: 523-6(1966). (In German).

The momentum of cosmic ray muons can be measured by means of a magnetic spectrograph. Two trays of Geiger-Müller counters are placed above and two trays below the field of an electromagnet. When a muon traverses the telescope one counter discharges in each tray. The momentum of the muon then can be calculated in a rough manner out of the geometrical positions of the discharged counters. An electronic computer was developed for the calculation of the momentum. The computer is based on analog circuits. The polarity of the output pulse refers to the sign of charge of the muon and the height is proportional to the momentum. The triggering pulse appears nearly 5 μsec after a muon has passed the counter arrangement. (auth)

3284 STATISTICAL FLUCTUATIONS OF CURRENT IN MEASUREMENTS ON DETECTORS FOR IONIZING RADIATION. Weber, K.-H. (VEB Vakutronik Dresden). Isotopenpraxis, 2: 349-54(Sept. 1966). (In German).

Assuming simplified laws of energy transmission, relationships

for the relative mean square-root statistical error in measurements of current in ionization chambers or in any other proportionally amplifying detector for beta rays and quantum radiation have been derived and verified experimentally. In analogy to the statistical error in counting rate measurements the square of the relative statistical error is inversely proportional to the ionization or detector current and integration time constant. Moreover, the statistical error proves to be dependent on the dimensions of the chamber, the particle or quantum energy, and the pressure of filling gas. From the relationships between statistical error, ionization current, and time constant a natural limit of minimum dose rate or radiation intensity detectable by an ionization chamber when statistical error and time constant are preset has been derived. (auth)

3285 MOBILE LABORATORY FOR MEASURING THE NATURAL RADIOACTIVITY OF THE ATMOSPHERE. Blanc, Daniel; Birot, Andre; Fontan, Jacques (Univ., Toulouse). Ind. At., 10: No. 9-10, 87-95(1966). (In French).

A natural radioactivity detection set is described which enables separate and continuous measurements to be made of the concentration of radioactive gases (radon and thoron) in the air and of the results of their decomposition. The apparatus is installed on a vehicle of the delivery-van type, enabling measurements to be made on the spot in various places. (auth)

3286 NEUTRON LIFETIME IN A COSMIC-RAY NEUTRON MONITOR. Pearce, R. M.; Mason, G. R. (Univ. of Victoria, B. C.). Nuovo Cimento (10), 45A: 1030-2(Oct. 21, 1966).

Diffusion theory is used to show that many modes exist in the spatial distribution of the neutron density within a cosmic-ray neutron monitor and that each mode has a distinct lifetime. The values of the largest two predicted mode lifetimes are found to agree with the Rome monitor measurements. (L.B.S.)

3287 ON THE PROPERTIES OF POINT COUNTER WITH QUENCHING VAPOUR ABOVE FREE LIQUID SURFACE (EXO-ELECTRON DETECTOR). Stepniowski, I. (Pedagogical Coll., Opole, Poland). Acta Phys. Pol., 30: 365-73(Sept. 1966).

A new type of an open counter with quenching vapor was designed. This constructional solution is characterized by stable operation. Properties of the counter were investigated. It was shown that an important parameter of the counter is the radius of the cathode. (auth)

3288 MEASUREMENT AND ANALYSIS OF SPARK CHAMBER TRACKS WITH A VIDICON SCANNING SYSTEM. McEwen, J. G.; Seidman, A. (Univ. of Southampton, Eng.). Nucl. Instrum. Methods, 42: 273-6(July 1966).

Measurements of pion tracks in spark chambers have been made with the Vidicon scanning system. They have been analyzed to give the rms projected angle of multiple scattering in lead, this being one of the simplest physically significant quantities whose measurement tests at the same time the precision of the system. The measurements were found to be reliable even in unfavorable conditions and programming for track recognition was relatively simple. Since the scanning is done with respect to initial reference marks but not to individual gaps and can be performed on live spark chambers, it is likely that the system can be used for both wide-gap and streamer chambers. (auth)

3289 GASEOUS TARGET SCATTERING CHAMBER OF SMALL VOLUME WITH A DIFFERENTIAL PUMPING SYSTEM. Gobert, G.; Mani, G. S.; Sadeghi, A. (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Instrum. Methods, 42: 250-7(July 1966). (In French).

An accurate small volume gas scattering chamber installed on the Van de Graaff tandem at C.E.N. Saclay is described. Detailed design factors for the differential pumping system are given. The chamber can have up to 32 detectors. The associated electronics is briefly described. Some experimental data are presented together with a short description of the solid angle calculation. (auth)

3290 SPECIAL IONIZATION CHAMBERS FOR ABSOLUTE MEASUREMENT OF HIGH ENERGY BREMSSTRAHLUNG INTENSITY. Komar, A. P.; Kruglov, S. P.; Lopatin, I. V. (Ioffe Inst. of Physics and Tech., Leningrad). Nucl. Instrum. Methods, 42: 235-40(July 1966).

The various types of ionization chambers used for measurement of the bremsstrahlung intensity are discussed. A brief description of these chambers is given and their characteristics, in particular: sensitivity at different peak energies of the beam, highest possible values of the measured intensities and data dependence on the beam diameter, are discussed. It is shown that absolute chamber calibrations made in different laboratories by different methods lead to results which agree within the accuracy of the measurements. The quantameter turns out to be the most useful for intensity measurements because its sensitivity only slightly depends on the energy and may be calculated on theoretical grounds. (auth)

3291 MULTIPLE SCATTERING OF FAST NEUTRONS IN ^{6}Li-GLASS SCINTILLATORS. Zetterstroem, H.-O.; Schwarz, S.; Stroemberg, L. G. (Research Inst. of National Defence, Stockholm). Nucl. Instrum. Methods, 42: 277-82(July 1966).

The multiple scattering of keV-neutrons in ^{6}Li-loaded glass scintillators was studied by a Monte Carlo technique. The computer program can be used to calculate corrections to the neutron detection efficiency for scintillators of specified composition. This makes possible their use as standards for absolute flux measurement of monoenergetic neutrons in the keV range. Results are presented referring to the glass Nash and Thompson GS 20. (auth)

3292 LIQUID-NITROGEN-COOLED-ADSORPTION NEON-RECOVERY SYSTEM. Bailey, B. M.; Buffington, A. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Nucl. Instrum. Methods, 42: 307-8(July 1966). (MIT-2098-234).

A liquid nitrogen-cooled-adsorption system was designed for recovering neon from the M.I.T Mascot, a momentum analyzing spark chamber with scintillation counters as triggers, which was used as the detection medium. The characteristics and performance of the system are discussed and a schematic flow diagram presented. (B.G.D.)

3293 DEAD TIME MEASUREMENT OF G.M. COUNTERS. Fava, L.; Sangiust, V. (Politecnico, Milan). Nucl. Instrum. Methods, 42: 325-6(July 1966).

A technique most often used for determining the dead time of a G.M. counter is to measure the counting rate of a short-lived sample of well known half-life. A method of treating the data obtained with the sample, which gives the value of dead time together with a check on the randomicity of the G.M. data, is presented. (B.G.D.)

3294 AVERAGE ENERGY PER PAIR IN p-TYPE SILICON WITH 5 MeV ALPHA PARTICLES. Buys, W. L. (Univ. of Ghent). Nucl. Instrum. Methods, 42: 329-30(July 1966).

The value of the average energy required per hole-electron pair in p-type silicon was investigated with a diffused junction detector, having a net surface of 5 mm^2, 2μm diffusion depth and made from 10 to 20 kΩ · cm p-type silicon and with plane thin (^{233}U, ^{244}Cm) alpha sources. (B.G.D.)

3295 MODULATION METHODS FOR LOW-LEVEL COUNTING IN THE PRESENCE OF BACKGROUND. Vincent, C. H. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Nucl. Instrum. Methods, 42: 299-301(July 1966).

The question as to whether the modulation method offers any improvement in the counting of a small constant rate ρ_s due to a source in the presence of a relatively large constant background rate ρ_b such that $\rho_b \gg \rho_s$ is discussed. (B.G.D.)

3296 BERNOULLI TRIALS AND COUNTING CORRELATIONS IN NUCLEAR PARTICLES DETECTION. Pacilio, N. (CNEN-CSN, Casaccia, Italy). Nucl. Instrum. Methods, 42: 241-4(July 1966).

An application of statistical methods to the theoretical and experimental analysis of some counting processes is realized. A theory of the correlations due to nonideal measuring instrumentation is derived and various experiments involving sources, of random and correlated events are presented. This correlation method suggests a simple measurement of dead-time for counting devices. It also allows a correct experimental approach to the short-time probability methods (i.e., prompt neutron lifetime measurements in nuclear reactors). (auth)

3297 A CONSTANT ACCELERATOR FLY-BACK MOESSBAUER SPECTROMETER. Brafman, H.; Greenshpan, M.; Herber, R. H. (Weizmann Inst. of Science, Rehovoth, Israel). Nucl. Instrum. Methods, 42: 245-9(July 1966).

A constant acceleration drive circuit suitable for ^{57}Fe, ^{119}Sn and ^{83}Kr Mössbauer studies, int. al., is described. This drive, which uses the staircase signal of the address scaler of a multichannel analyzer, employs a rapid fly-back motion at the end of the spectrum sweep, thus maximizing the total active time of the data storage capabilities without necessitating spectrum folding procedures. Calibration data obtained using the magnetic hyperfine splitting in metallic iron show that the calibration constant is independent of the relative source-absorber velocity (analyzer address) and that the resulting resonance lines are undistorted. A method for accurately determining the resonance line midpoint is presented. (auth)

3298 SOLID-STATE DEVICES AS DETECTORS OF COHERENT HIGH-ENERGY INTERACTIONS. Lander, R. L. (Univ. of California, San Diego, La Jolla); Mehlhop, W. A. W.; Lubatti, H. J.; Schnurmacher, G. L. Nucl. Instrum. Methods, 42: 261-8(July 1966). (UCRL-16603).

The possibility of using a solid-state radiation detector as a target is considered in order that the recoil energy of the struck nucleus, as well as any charged nuclear fragments, may be measured. In this way, one can discriminate against those interactions leading to breakup of the nucleus (noncoherent) and can also measure the momentum transfer to the nucleus with considerably better precision than might otherwise be possible. As a first test of such a detector, the distribution in energy deposited in a 1-mm-thick lithium-drifted silicon detector when 730-MeV protons are scattered at small angles by nuclei in the detector were observed. When the protons traverse the silicon without interacting, the characteristic Landau energy-loss distribution is observed. When the protons scatter at small angles, their energies and path lengths in the silicon are practically unchanged. The recoil silicon nucleus, however, deposits most of its kinetic energy, T_{Si}. This energy is added to that from the proton, so the observed energy distribution in the silicon detector is shifted upwards by T_{Si} when the proton scatters. This second peak was observed at proton scattering angles of 4.3, 5.4, and 6.3 deg in the laboratory system and confirm the predicted energy shift. The potential applications of this technique are discussed. (auth)

3299 SCATTERING CHAMBER FOR USE WITH COOLED LARGE AREA LITHIUM-COMPENSATED SILICON RADIATION DETECTORS. Dodge, W. R.; Coleman, J. A.; Domen, S. R. (National Bureau of Standards, Washington, D. C.). Nucl. Instrum. Methods, 42: 181-7(July 1966).

A scattering chamber designed to be used with large area, lithium-compensated silicon radiation detectors was constructed. The chamber has provision for cooling a circular array of detectors to 77°K to achieve shorter charge collection time and better energy resolution than could be obtained with room temperature operation. The apparatus was designed to be used with the NBS 180-MeV synchrotron in photoproton experiments in the 2 to 35 MeV proton energy interval. (auth)

3300 COMPARISON OF LEADING-EDGE AND CROSSOVER TIMING IN COINCIDENCE MEASUREMENTS. Bell, R. E. (McGill Univ., Montreal). Nucl. Instrum. Methods, 42: 211-12 (July 1966).

The statistical limits of the resolving time are compared for leading-edge and crossover timing in coincidence measurements. The results show that leading-edge timing is always superior, the factor of superiority being greater for slower detector responses, i.e., for those cases where the convenience of crossover timing is the greatest. For NaI(Tl) scintillation counters, leading-edge timing gives better time resolution by a factor estimated to be 13.7. (auth)

3301 DEVELOPMENT OF CONTINUOUS γ PULSE HEIGHT DISTRIBUTIONS. Kreische, W.; Lampert, W.; Loos, G. (Univ., Erlangen-Nuremberg, Erlangen, Ger.). Nucl. Instrum. Methods, 42: 188-96(July 1966). (In German).

In order to unscramble continuous pulse-height distributions, measured with a scintillation spectrometer, to the true incident photon spectrum, especially of the internal bremsstrahlung, a special method is necessary. The formation of the unscrambling matrix and the energy spectra, which are received as solutions of linear systems of equations, are discussed. The matrix is tested by using discrete γ spectra. The oscillations, which occur when the systems of equations are solved, are studied; and an iterative method for unscrambling is described, which is able to suppress these oscillations. The limit of the efficiency of the method is given. (auth)

3302 NEW POSSIBILITY FOR THE DETERMINATION OF ENERGY DISTRIBUTIONS OF CHARGED PARTICLES IN SOLID STATE NUCLEAR TRACK DETECTORS. Somogyi, G. (Inst. for Experimental Physics, Debrecen, Hungary). Nucl. Instrum. Methods, 42: 312-14(July 1966).

A method is discussed for determining the energy distribution of charged particles in solid-state nuclear track detectors. The method is based on the condition that an ionizing particle passing through the detector will lose energy in its interaction with matter. The length of the primer damage is then correlated to the total energy loss of the particle. Consequently, the radius of the primer channel of particles entering at right angles to the surface is determined by its energy (radius is inversely proportional to energy of the particle). This characteristic of particle radius vs. particle energy is investigated with respect to chemical etching procedures in order to determine its effect on this technique. (B.G.D.)

3303 LOW-ENERGY SPECTRA MEASURED WITH 0.7-keV RESOLUTION. Elad, E.; Nakamura, M. (Univ. of California, Berkeley). Contract W-7405-eng-48. Nucl. Instrum. Methods, 42: 315-17(July 1966). (UCRL-16760).

An improved version of a FET amplifying stage discussed by Elad (Nucl. Instr. and Meth. 37, 327(1965)) is described. It was used as an input stage of a low-noise preamplifier for semiconductor radiation detectors. The elimination of several noise sources has made possible a spectrometer resolution of 0.7 keV, compared with 1.1 keV resolution achieved with the basic circuit. (B.G.D.)

3304 AN INDICATING CIRCUIT FOR AFTERPULSES OF GEIGER–MUELLER COUNTERS. Weiss, H.; Masanz, E. (Oestereichische Hochschule, Vienna). Atomkernenergie, 11: 489-92(1966). (In German).

A circuit is described which indicates afterpulses of Geiger–Mueller counters during normal operation of the counter tubes. The values for design and adjustment of the circuit are obtained from the time distribution of the afterpulses following a normal pulse and from statistical considerations. (auth)

3305 SECONDARY STANDARDIZATION OF γ-EMITTING RADIONUCLIDES IN THE mCi-RANGE BY MEANS OF A MODIFIED GOLD-LEAF ELECTROSCOPE. Oberhofer, M. (Technische Hochschule, Munich). Atomkernenergie, 11: 481-7(1966). (In German).

A simple gold-leaf electroscope was constructed for secondary standardization of γ-emitting radionuclides within an activity range of some mCi to several 100 mCi. The electroscope serves both as an ionization chamber and meter. The reproducibility of the instrument is about ±0.3%. The accuracy with which activities of γ-emitting radionuclides can be measured is ±2%, if the branching ratios of the decay schemes of the nuclides are known sufficiently well. (auth)

3306 RESONANCE NEUTRON SPECTROMETER /Q-2804/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE–1494).

22 drawings.

A BF_3 proportional counter, 3 in. in dia, is used in a resonance neutron spectrometer to measure the contribution low-energy neutrons make to overall dose. The spherical counter is contained within a spherical annulus of enriched powdered boron. A conical annulus of boron surrounds an air collimator. In front of the collimator are ^{10}B filters of graduated thickness. Depending on the ^{10}B in the filter, ~99% of the neutrons below a given energy will be absorbed in a filter of a given thickness. Neutrons of higher energy will be transmitted and a neutron spectra can be "chopped" into a step function relating neutron flux to energy. The instrument is remotely controlled. (For details see TID-4100 Suppl. 37). (F.S.)

3307 SOLID STATE ALPHA MONITOR (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE–1495).

1 drawing.

The instrument was designed to monitor the position of elution peaks during the separation of transplutonium elements by an ion exchange column. The instrument is comprised of a solid-state detector, a charge-sensitive preamplifier, a main amplifier, and a count-rate meter. (For details see TID-4100 Suppl. 37). (F.S.)

3308 PRODUCTION AND INVESTIGATIONS OF X-RAY PROPORTIONAL COUNTERS IN THE DETECTOR LABORATORY OF THE NUCLEAR TECHNOLOGY INSTITUTE AT THE MINING-METALLURGY ACADEMY IN KRAKOW. Elen, K.; Ostrovskii, K. 9p. (In Russian). (CONF-641024–13). DTIE.

From Symposium on Use of Radioisotopes, Warsaw.

This laboratory specializes in the field of x-ray proportional counters for use in fluorescence and absorption analytical techniques in which the energy range is 1.5 to 80 keV. Ten types have been developed, some prototypes of which are now in use. Effort has been expended in the direction of as large windows as possible with large-diameter metal cylinders and with gas pressures near atmospheric. Data are presented on five counters, three with 2-mg/cm^2 aluminum windows and two with 0.2- to 0.4-, beryllium windows. Models were made with argon, krypton, xenon, and isopentane filling. In some cases the xenon-filled models showed poorer resolution than the argon- or krypton-filled models at low energies. With 30 μCi of ^{125}Sb the molybdenum, iron, and copper K lines, as well as others, could be obtained for calibration purposes. (TTT)

3309 MEDICAL RADIATION DOSIMETERS MANUFACTURED BY THE DRESDEN NATIONAL VACUTRON PLANT. Shubert, G. (Vakutronik, Dresden). 9p. (In Russian). (CONF-641024-6). DTIE.

From Symposium on Use of Radioisotopes, Warsaw.

In addition to laboratory, industrial, and field equipment, the Dresden Vacutron plant makes nuclear electronic equipment for medical use. This includes x-ray dosimeters with an ionization chamber, amplifier, and recording device for continuous dose monitoring in x-ray therapy; an automatic exposure regu-

lator that ensures a constant exposure to a predetermined value and can be used with different types of x-ray equipment; a thermoluminescent dosimeter for biology and radiation therapy use, but which can also be used for determining the dose in a reactor or an accelerator field for radiation protection purposes; and an x- and gamma-radiation dosimeter that has a range from 0.1 to several hundred roentgens per hour, is independent of the beam energy and independent of direction in the range 20 keV to 1.2 MeV, has a small-scale recorder, responds rapidly, and is of sturdy construction. (TTT)

3310 CONSTRUCTION, TECHNICAL CHARACTERISTICS, AND USE OF A WHOLE-BODY COUNTER. Kornevich, Veslava; Linetski, Yuliyan; Kosterkevich, Andzhei. 24p. (In Russian). (CONF-641024–10). DTIE.

From Symposium on Use of Radioisotopes, Warsaw.

The design of the counter is shown in diagrams. The NaI(Tl) scintillation detector, 15 by 8 cm, and the 110-mm-dia photomultiplier are inside a 190- by 120- by 110-cm steel chamber. The 15-cm-thick walls of the chamber are made from sand finished steel taken from old boilers, for minimum background radioactivity, and faced with 0.5 cm of lead. The design of the chamber permits measurements to be made in both the standard-chair and the 1-meter-arc positions. The system was calibrated by measuring the natural activity of subjects, then giving them a single dose of ^{137}Cs, ^{42}K, or ^{90}Y and measuring their activities again 16 to 18 hr later; and by measuring the activity of a water-filled phantom made from plastic to which were added, in turn, 0.05 μCi of ^{137}Cs, 700 g of potassium, and 2 μCi of ^{42}K. The system was calibrated for ^{226}Ra with a point source of ^{226}Ra and a 14-g/cm^2 wood phantom. (TTT)

3311 BALANCED GASEOUS RADIATION OR PARTICLE DETECTORS. Bernstein, Stanley (to General Electric Co.). U. S. Patent 3,277,329. Oct. 4, 1966. Filed Oct. 31, 1961.

An invention is described which relates to gaseous detectors used for detecting high-energy particles or radiation, or both, and more particularly, in a preferred embodiment, to a system of two ionization chambers used together as balanced detectors. (B.G.D.)

3312 FAST NEUTRON SPECTROMETER UTILIZING LITHIUM CONTAINING FILMS. Bokhari, M. S.; Verbinski, V. V.; Love, T. A. (to U. S. Atomic Energy Commission). U. S. Patent 3,290,500. Dec. 6, 1966.

A spectrometer is described which eliminates the background radiation from the neutron energy spectrum measurement by taking alternate measurements of signals from samples of ^6Li and ^7Li when subjected to radiation from the same source, and then subtracting the latter from the former to eliminate the background effect. (AEC)

3313 ACOUSTIC SPARK CHAMBER. Kirsten, Frederick A.; Maglic, B. C. (to U. S. Atomic Energy Commission). U. S. Patent 3,278,892. Oct. 11, 1966.

This patent relates to a spark chamber with means for acoustically locating the position of charged particle tracks therein. Sonic probes placed in each gap of the chamber respond to the shock waves emanating from the sparked particle paths and transmit the shock waves to external piezoelectric transducers. The acoustic delay of the shock waves from the sparks to the probes is measured in a timing circuit. From the delay information, the position and angle of the spark paths are reconstructed by a computer program and made readily available, as opposed to the time consumed by conventional photographic recording methods of spark chamber events. (AEC)

3314 SEMICONDUCTOR DETECTOR METHOD. Miller, G. L.; Wagner, S. E. (to U. S. Atomic Energy Commission). U. S. Patent 3,272,668. Sept. 13, 1966.

This patent relates to drifted semiconductor radiation detectors. A method is described by which lithium is drifted into a lithium alloyed p-doped silicon crystal by reverse biasing the crystal with a constant wattage supply while Joule heating generated by the reverse biasing is removed by a vapor phase coolant. In one embodiment, coolant is maintained near its boiling point adjacent to the crystal surface whereby a deep lithium drifting is accomplished efficiently and expeditiously. (AEC)

Radiation Dosimeters

Refer also to abstract 3117.

3315 (AD-641559) EVALUATION OF THE RESPONSE OF SILICON DIODE DOSIMETERS TO FAST NEUTRONS. Vega, Eloy P.; Kilminster, David T.; McNeilly, John H. (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). Oct. 1966. 44p. (NDL-TM-31). CFSTI $3.00 cy, $0.65 mn.

Conductivity-modulated, silicon p-n junctions of two base widths (10- and 50-mil) were exposed to a burst of fast neutrons. High-level lifetime, reverse-recovery lifetime, and forward voltage at four constant current levels were correlated with fast neutron kerma as measured by threshold detectors. This correlation showed that the sensitivity of the diodes varied with respect to kerma. The curves of high-level lifetime versus kerma and reverse-recovery lifetime versus kerma have two changes in slope, at 10^5 ergs/g and at 10^6 ergs/g. The 10-mil diodes exhibited excellent reproducibility for both lifetime measurements; however, only 55 percent of the forward-voltage measurements were within ±10 percent of the average. The lifetime measurements of the 50-mil diodes were very poor (only 31 percent of the data was within ±10 percent) while the forward-voltage measurements were better (84 percent of the data was within ±10 percent). (auth)

3316 (CLOR-Fonton–53) ZWIEKSZENIE ZAKRESU POMIAROWEGO DAWEK PROMIENIOWANIA JONIZUJACEGO PRZY POMOCY BLON DOZYMETRYCZNYCH PRODUKCJI KRAJOWEJ. (Ionizing Radiation Measurements by Using Wide-Range Polish Monitoring Films). Musialowicz, T.; Wysopolski, J.; Jasinska, T.; Michalski, Z. (Centralne Laboratorium Ochrony Radiologicznej, Warsaw (Poland)). 1966. 23p. (In Polish). Dep.

The results of investigations of new wide-range dosimetric films produced by Polish Photochemical Factory Foton are described. The tests were performed according to CLOR's assumptions. They are double-emulsion films having two different sensitivity emulsions on the same base. The most suitable of the tested film batches was batch No. 50123. The measurement range of the films for gamma rays of ^{60}Co is between 60 mR and 1300 R, the fog densities ranged 0.18 ± 0.04. All the tested film batches had the lower contrast, compared to Foton 64 CUK film in current use. (auth)

3317 (ORNL-P–2686) DOSIMETRY, SHIELDING AND SCATTERING. [PART] II. Thorngate, J. H. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 38p. (CONF-660815–2). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Conference on Principles of Radiation Protection, Oak Ridge, Tenn.

A discussion is presented on research, past and present, in radiation dosimetry. Research related closely to radiation protection and the design and development of dosimeters and dosimetric systems is included. Typical research problems encountered are nuclear accident, radiobiological and radiochemical experiments, and experiments to measure depth dose. (B.G.D.)

3318 CHARACTERISTICS OF PHOTOMULTIPLIERS FOR USE IN THERMOLUMINESCENT DOSIMETRY SYSTEMS. Lingertat, H. (Technical Univ., Dresden). Isotopenpraxis, 2: 374-7(Sept. 1966). (In German).

The usefulness of some photomultipliers for light detection in a thermoluminescent system is discussed. The response of the overall sensitivity and the dark current on step-like light signals are reported. The E. M. I. Type 6256 S photomultiplier appears to be most suitable for detection of thermoluminescent light emission. (auth)

3319 PREPARATION OF POLYCRYSTALLINE LiF STORAGE PHOSPHORS FOR USE IN THERMOLUMINESCENT DOSIMETRY. Edelmann, B. U. (Technical Univ., Dresden). Isotopenpraxis, 2: 371-4(Sept. 1966). (In German).

The activator effects of a large number of cations on the formation of an intensive glow maximum in the thermoluminescence of LiF at 200°C were investigated. The most effective activators were found to be trace amounts of magnesium, calcium, and titanium. The characteristics of the prepared phosphors were compared with analytical results. (tr-auth)

3320 THE USE OF THERMOSTIMULATED EXOELECTRON EMISSION OF LiF IN DOSIMETRY. Frank, M.; Knoll, P.; Mueller, F. (Technical Univ., Dresden). Isotopenpraxis, 2: 369-71(Sept. 1966). (In German).

The thermostimulated exoelectron emission of LiF phosphors has been investigated after excitation with ionizing radiation. The exoelectron emission has been measured with a point counter. The results are discussed with respect to an application in dosimetry. (auth)

3321 DOSIMETRY OF INTENSIVE RADIATION FIELDS OF GAMMA AND ELECTRON RAYS WITH DYED CELLOPHANE. Stolz, W. (Technical Univ., Dresden). Isotopenpraxis, 2: 366-9(Sept. 1966). (In German).

Measurements of high doses in intensive gamma and electron radiation fields used for sterilization, pasteurization, and improvement of plastics may be done by bleaching commercial dyed cellophane. The measuring range extends from 1 to 100 Mrad. No detectable postirradiation effects were observed over a pe-

riod of 1000 hr at temperatures of 20 and 50°C. No influence of the dose rate and the energy was found. The depth dose distribution of 1.5 MeV electrons in cellophane was measured with a stack of 200 cellophane films. The relation between the optical density and the absorbed dose is discussed. (auth)

3322 CALIBRATION OF THE FERROUS SULPHATE DOSIMETER BY IONOMETRIC AND CALORIMETRIC METHODS. Fregene, A. O. (Cambridge Univ., Eng.). Nature, 212: 818-19 (Nov. 19, 1966).

Dosimetric calibrations were made by ionometric, particle counting, and microcalorimetric methods and $G_{Fe^{++}\rightarrow Fe^{+++}}$ values established with a reasonable degree of accuracy from beta, gamma, and x rays of various energies. Using the $G_{Fe^{++}\rightarrow Fe^{+++}}$ values obtained by this method, absorbed radiation doses can be estimated to an accuracy of some ±2% using a ferrous sulfate dosimetry system. (D.H.M.)

3323 COMPARATIVE STUDY OF A SERIES OF IONIZATION CHAMBERS IN ELECTRON BEAMS OF 20 AND 10 MeV. Dutreix, J.; Dutreix, A. (Institut Gustave Roussy, Villejuif, France). Biophysik, 3: 249-58(1966). (In French).

The ionization chamber introduces in the medium irradiated by high energy electrons a disturbance of the electronic flux which appears in the discrepancies between the depth ionization curves obtained with different chambers. For 20-MeV electrons it has been possible for the chambers which have been used to assess a point of measurement i.e. also to derive from the measurements the ideal ionization curve which would be obtained with a cavity of vanishing dimensions. Using the polarization correction factor this ideal curve is brought in close agreement with the depth dose curve given by $FeSO_4$ dosimetry; this agreement is satisfactory for most of the practical applications. However there remains a slight discrepancy, the origin of which could not be demonstrated and the $FeSO_4$ seems to be more reliable when a high accuracy is required. For 10-MeV electrons no general rule of correction could be found on account of the great diversity between the curves relevant to the different chambers. (auth)

3324 BAUSCH AND LOMB MICRODOSIMETER READER /Q-2582/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1404).

2 drawings.

A Bausch and Lomb No. 33-66-02 microdosimeter was modified to be used by the ecology group. The modification provides increased long-term stability and approximately 10 to 15 times the galvanometer readout sensitivity originally provided. The differential vacuum-tube circuitry used to drive the galvanometer from the photomultiplier output was modified. Over-range galvanometer protection was increased by using back-biased diodes from plate to plate in the voltmeter circuit. The photomultiplier tube was replaced and a ten-turn potentiometer for fine zero adjustment was used. (For details see TID-4100, Suppl. 37). (F.S.)

3325 GAMMA RADIATION MONITOR (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1497).

16 drawings.

This accurate and reliable wide-range gamma process monitor has a novel and readable scale calibrated from 0 to 1000 mR and covering 3 decades in 28 linear divisions. The meter scale and response are divided into 3 decades: in units of 1 from 0 to 10; in units of 10 from 10 to 100; and in units of 100 from 100 to 1000. The instrument operates in the pulse mode, with the integrated current from the G-M tube used only to prevent the meter current from dropping in the event the pulse circuitry should be paralyzed by a radiation excursion. There is an "up-scale" alarm and a "circuit inoperative" alarm. Each has normally open and closed contacts for external controls and for an audible signal and an indicator light. The instrument is packaged in conformance with the AEC standards for nuclear instrument modules (See CAPE-1477 Nuclear Instrument Modules). (For details see TID-4100 Suppl. 37). (F.S.)

3326 SOME APPLICATIONS OF CAVITY THEORY TO CONDENSED-STATE RADIATION DOSIMETRY. Burlin, T. E.; Chan, F. K. (The Polytechnic, London). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-78/60, 40p. (CONF-661005-10). DTIE.

From Symposium on Solid-State and Chemical Radiation Dosimetry, Vienna.

Measurement of the absorbed dose in a medium exposed to ionizing radiation necessitates the introduction of a radiation-sensitive device into the medium. Normally this device will differ from the medium in both atomic number and density and it therefore constitutes a discontinuity, which will be referred to as a cavity. Through association with the ionization chamber the term cavity often denotes a gas-filled space in a solid. There is no fundamental reason for this limitation and generally the cavity may be in the solid, liquid or gaseous phase. Both the Bragg-Gray and the Spencer-Attix theories are applicable to sizes which do not modify the electron energy spectrum established in the surrounding medium. This limits the application of these theories to solid and liquid radiation dosimeters having dimensions of about 10^{-5} cm and they are therefore seldom of practical use. Cavity theory can be modified to account for the change in the shape of the energy spectrum due to the presence of the cavity and also for the change in the total energy in the spectrum. This modification removes the limitation of the size of cavity, to which cavity theory is applicable, thus permitting its use with solid and liquid state dosimeters. The ferrous sulfate dosimeter is considered as a specific example. The response as a function of the size of the irradiation cell is calculated. The results are compared with experiment and may in part explain the area/volume dependence of this dosimeter reported by other workers. (auth)

Radiometric Instruments

3327 (BNWL-SA-264) X-RAY FLUORESCENCE TESTER FOR DETECTING URANIUM CONTAMINATION. Jackson, C. N. Jr.; Jacob, R. B. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1965. Contract AT(45-1)-1830. 24p. (CONF-650809-5). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Society for Applied Spectroscopy, 4th National Meeting, Denver, Colo.

A prototype x-ray fluorescence tester for detecting uranium contamination in nuclear reactor fuel elements has been constructed and evaluated. A 150 kV x-ray beam excites the volume under test and an x-ray spectrometer measures the K-line fluorescence activity from uranium impurity. Uranium concentrations in a range from 1 to 10% were measured in a weld closure test volume of 0.25×10^{-3} in.^{3} at a scan rate of 5 in./min. A difficult geometry problem was overcome by a unique floating collimator that compensated for variations in fuel shape. An alternate photon source, radioactive ^{192}Ir, exhibited favorable K-line excitation capability when compared to the x-ray source. (auth)

3328 VOLUMETRIC CALIBRATION OF NEUTRON MOISTURE PROBES. Douglass, James E. (Dept. of Agriculture, N. C.). Soil Sci. Soc. Amer., Proc., 30: 541-4(Sept.-Oct, 1966).

A volumetric method of estimating the slope (b coefficient) of a neutron moisture probe calibration curve is discussed. Coefficients obtained for three probes by this method did not differ significantly between soil series or between horizons within a series. Simply dividing the count rate in water by 100 gave a value virtually identical to the b coefficient determined volumetrically for these probes and soils. Agreement was excellent between measured outflow and outflow predicted from neutron measurements made with a volumetrically calibrated moisture probe. (auth)

3329 INVESTIGATION OF THE BEHAVIOR OF A WET-STEAM TURBINE BY MEANS OF RADIOMETRIC METHODS. Loeffler, H. (Technical Univ., Dresden). Isotopenpraxis, 2: 361-4(Sept. 1966). (In German).

Measuring equipment and methods are described for the determination of local steam-density distribution in a wet-steam turbine: From the measured density distributions conclusions are drawn about the behavior of the turbine investigated. (auth)

3330 DESIGN OF RADIATION RELAYS USED FOR THREE-POSITION CONTROLLERS IN NON-COMPENSATED CONTROL LOOPS WITH DEAD TIME. Irmer, K. (Technical Univ., Dresden). Isotopenpraxis, 2: 358-61(Sept. 1966). (In German).

The design of radiation relays used for three-position controllers in simple control loops for measurement and level control is described. On the basis of the dead time of the radiation relays an optimal design of the radiation relays is determined. This permitted the use of the smallest activity of the radiation source. (auth)

3331 EVALUATION OF THE CLEANING EFFICIENCY OF SURFACES BY MEANS OF A RADIOACTIVE PENCIL. Yamashita, Yuji (Shimada Physical and Chemical Industrial Co., Ltd., Japan); Sasaki, Tsunetaka. Denki Tsushin Gakkai Zasshi, 48: 224-8(Nov. 1965). (In Japanese).

Removal of contaminations on the surface of metals and solid fabricates is extremely important in painting, galvanizing, and other coatings. In the radioactive tracer technique developed for detection of trace contaminations on such surfaces, some drawbacks in the conventional pencil technique such as insufficient sensitivity and unreliability in the detection are removed. The device consists of a radioactive pencil containing ^{14}C as the lead

of a pencil, and an end-window type G-M counter. The amount of ^{14}C radioactive graphite adhering onto the surface of stainless steel (23 mm in dia, 1 mm in thickness) and the amount removed with a supersonic generator were measured by this device under various conditions of surface roughness and cleaning. The sensitivity attained by this technique under the given conditions showed that it is very useful in inspection and control of clarities. The procedure for preparing the ^{14}C radioactive pencil is also described briefly. (NSA of Japan)

3332 GAMMA PHOTON TRACKER FEASIBILITY EXPERIMENTS. Malowicki, E.; Zulch, D. I. (Rome Air Development Center, Griffiss AFB, N. Y.). Nucl. Instrum. Methods, 42: 229-34(July 1966).

Experimental data which demonstrate the potential of obtaining bearing information on gamma ray photon sources at ranges out to 1200 feet are presented. Collimation of multislit collimators was achieved with beamwidths of approximately 0.5° and 17°. Energy levels of 0.661 MeV from ^{137}Cs and 1.17 and 1.33 MeV from ^{60}Co sources were used with effective strengths up to 20 curie. The dependence of the parameters affecting angular accuracy was evaluated as a function of range, base energies and containments in the ray path. (auth)

3333 QUANTITATIVE RELATIONS IN THE APPLICATION OF DEPTH AND SURFACE-EQUIPMENT FOR SOIL DENSITY MEASUREMENTS BY SCATTERING OF GAMMA RAYS. Kuehn, W. (Technische Hochschule, Hanover). Kerntechnik, 8: 496-9 (Nov. 1966). (In German).

A simple and clear representation of the radiation intensity on the detector can be obtained as a function of the geometry, density, energy, or atomic number, and ratio of atomic number to mass number from space distribution of the energy absorbed in the scattering medium for depth and surface equipment in soil density measurements. The intensity scattered in the direction of the detector and the important input magnitudes were derived for such a detector. The results obtained were compared with known experimental results. (J.S.R.)

3334 CONSTRUCTION OF RADIOMETRIC DEVICES FOR INDUSTRIAL GEOPHYSICS AT THE PETROLEUM INDUSTRY'S GEOPHYSICAL ESTABLISHMENT IN KRAKOW. 7p. (In Russian). (CONF-641024-4). DTIE.

From Symposium on Use of Radioisotopes, Warsaw.

A two-channel radiometric probe is made for simultaneous logging of boreholes by the gamma and neutron–gamma methods. The maximum operating temperature is 100°C. The two models of the probe have diameters of 102 and 75 mm, respectively, and allowable pressures are up to 600 kg/cm^2. A small scintillation probe for gamma, neutron-gamma, and neutron-neutron logging makes measurements faster than a probe with a G–M counter. A three-channel surface-based radiometric panel is made for simultaneous measurements of three different parameters. A "cementometer" was designed and manufactured in 1963 for determining the characteristics of cemented boreholes with a diameter of 6$^7/_8$ in. by a gamma–gamma method. It has three independent channels. Data on all the described instruments are presented. (TTT)

3335 SAFETY DEVICE FOR THE DETECTION OF DAMAGES OF A RADIOACTIVE SOURCE MOUNTED IN DEVICES FOR THE MEASUREMENT OF DENSITY OR THICKNESS. Schuetz, Gerhard; Seltmann, Hans (to VEB Vakutronik Dresden). German Patent 1,225,781. Sept. 29, 1966. Filed Dec. 2, 1963.

A safety device, which consists of a radiation transparent, spring-loaded disc located between the radiation source which is attached to a chassis, and the material to be measured is described. The disc is moved automatically by the spring force on touching, thereby actuating an electrical contact which releases an alarm signal. (Gmelin Inst.)

3336 METHOD AND APPARATUS FOR TRACING FLUID FLOW THROUGH POROUS MEDIA. Hawkins, R. H.; Albenesius, E. L.; Haskell, C. C. (to U. S. Atomic Energy Commission). U. S. Patent 3,291,997. Dec. 13, 1966.

A method of tracing fluid flow in soils and the detector probe used are described. After a circular array of equally spaced holes are drilled to a predetermined depth above the water table, an access hole is drilled in the center of the array to a greater depth. A quantity of D_2O is deposited in each of the holes and a probe comprising an integral gamma radiation source and neutron detector is placed in the access hole. Gamma radiation produced by the source has an energy greater than the threshold value for the (γ,n) reaction with deuterium. By moving the probe in the vicinity of and relative to the depth of the holes, the neutrons produced by the (γ,n) reaction are measured by the detector at various positions over a period of time. The probe used comprises an annular cylinder of NaOH wherein the sodium constituent is substantially ^{24}Na, a cylindrical neutron detector tube of greater length than, and extending through the NaOH cylinder, and an outer encasement of a gamma ray and neutron permeable material such as polystyrene. (AEC)

Miscellaneous Instruments and Components

Refer also to abstracts 3471 and 3756.

3337 (AEEW-R-486) A MULTI-CHANNEL, FAST SCANNING, RECORDER. Adnams, D. J.; Salt, K. J.; Wintle, C. A. (Atomic Energy Establishment, Winfrith (England)). May 1966. 20p. BIS $1.10. HMSO 5s. 6d.

The design of a fast-scanning instrument which measures the outputs from 216 thermocouples every 5 seconds, records them individually on a chart and provides alarm facilities is reported. (auth)

3338 (CEA-R-2995) COMPORTEMENT EN TEMPERATURE DES COUCHES PHOTOEMISSIVES. CAS DES PHOTOMULTIPLICATEURS UTILISES DANS LES COMPTEURS A SCINTILLATIONS. (Temperature Behavior of Photo-Emissive Films. The Case of Photo-Multipliers Used in Scintillation Counters). Ardalan, Abdul-Hamid (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1966. 102p. Dep. mn.

Thesis. Submitted to Paris Univ., France.

The changes in the spectral sensitivity of 3 types of normal photocathodes (Cs_3Sb, tri-alkali, and bi-alkali without cesium) as a function of temperature are investigated. The photocathodes of cathodes of commercial photomultipliers (DARIO, E.M.I., R.C.A., A.S.C.O.P.) were used for these tests. The temperature range studied was –25 to +55°C (except for the bi-alkali photocathodes which were tested up to +150°C) and the wave-length range was 3,250 to 7,000 Å. After a brief review of photo-electric effect theories, the experimental device is described and the measurement results presented. Finally, an interpretation of these results is proposed. (auth)

3339 (EGG-1183-1285) SOME REMARKS ON CHRONOTRON ALPHA METER. Hansen, R. D.; Sedlmeyer, J. W. (Edgerton, Germeshausen and Grier, Inc., Las Vegas, Nev.). Oct. 20, 1966. Contract AT(29-1)-1183. 20p. (CONF-661020-3). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 13th Annual Nuclear Science Symposium, Boston, Mass.

The Chronotron Alpha Meter is an instrument developed to measure the time difference between two discrete levels of a pulse to an accuracy of a few picoseconds. The instrument output is a dc level which corresponds to this time difference. This instrument has been used to measure the rate of rise of fast single transient waveforms such as the exponent, alpha (α), of a positive exponential signal of the form $E = E_0e^{\alpha t}$. Other typical applications such as measuring time interval between pulses, linearity of ramps and the rise rate and shape of any continuously rising analytical functions are discussed. (auth)

3340 (SC-RR-66-585) DEVELOPMENT OF AN INCREASED SAMPLING RATE MONITORING SYSTEM. Whitfield, W. J.; Mashburn, J. C. (Sandia Corp., Albuquerque, N. Mex.). Oct. 1966. Contract AT(29-1)-789. 8p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A developmental device that samples air for small particles in clean rooms is described which differs from standard monitors in that it samples at an increased rate and is designed for very low concentrations of airborne particles. Test results, also included, indicating that this device is superior to present particle counters. (auth)

3341 (SC-TM-66-558) A HIGH-MEGOHM BRIDGE. Kendall, D. R.; Scott, E. W. (Sandia Corp., Albuquerque, N. Mex.). Nov. 1966. Contract AT(29-1)-789. 24p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A new bridge is described which simplifies the measurement of high-megohm resistors. The bridge uses a conventional Wheatstone circuit and is capable of measurements in the range 10^8 to 10^{14} ohms. The estimated measurement error varies from about 0.3 percent at 10^8 ohms to about 5 percent at 10^{14} ohms. The bridge simplifies two aspects of high-megohm resistor measurement which frequently cause errors: determining the voltage applied to the unknown resistance and standardizing the bridge. The use of an

electrometer detector and high-megohm ratio resistors results in a bridge of high sensitivity, thus allowing resistors to be measured with low voltage applied. (auth)

3342 (UCRL–13209) DEVELOPMENT OF A 40 KV ENERGY STORAGE CAPACITOR. Gooding, Terence J.; Hayworth, Bruce R. (Maxwell Labs., Inc., San Diego, Calif.). Apr. 1966. Contract W-7405-eng-48. 18p. (MLR–1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For Univ. of California Lawrence Radiation Lab., Livermore.

The development and testing of a 20 μF, 40 kV energy storage capacitor are described. The design goals are: minimum life, 100 discharges; voltage reversal 85%; ringing frequency, 100 kc; energy density, 7 joules/in.^{3}; and the configuration is compatible with mounting in a rack designed for a standard $7\frac{1}{4}$ by 14 by $24\frac{15}{16}$ in. energy storage capacitor. The test data show that these design goals can be achieved. Also it is shown that small capacitors can be consistently hi-potted to an energy density of 17 joules/in.^{3} in the winding. (J.F.P.)

3343 (UCRL–17112) COMPUTER-CONTROLLED FAST-LOGIC CIRCUITS. Jackson, H. G.; Kirsten, Fred; Mack, Dick A. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 7, 1966. Contract W-7405-eng-48. 18p. (CONF-660918–9). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From International Conference on Instrumentation for High Energy Physics, Stanford, Calif.

The extent to which a computer can be used to relieve the experimenter of the time consuming and exasperating routines of establishing, recording, and maintaining the operation of instrumentation for high-energy physics experiments is discussed. The design of future fast-logic circuits and their associated computer control is investigated. (B.G.D.)

3344 (Y-IA–40) VOLTAGE–SENSING DEVICE FOR MONITORING X RAYS. Pipes, E. W. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Nov. 11, 1966. Contract W-7405-eng-26. 9p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A safety device was constructed which can be used to determine if an x-ray machine is operating. The device, connected to the primary voltage lines of an x-ray generator, will provide a warning signal flashing light, horn, or buzzer, if it detects a voltage on the generator. The device may also be used as a safety monitor, or control element, on other types of variable voltage equipment. Although the primary application of the device was on high-voltage x-ray generators, it serves equally well as a safety monitor on such related variable-voltage equipment as: power supplies for neutron generators, electron beam welders, and furnaces; high-voltage test equipment. It has been used as a safety monitor only but could be used to initiate control functions. (auth)

3345 (UCRL-Trans–1335) ON THE TESTING OF A SKP-1 CONTROLLABLE FAST-RESPONSE PHOTOMULTIPLIER. Muchin, S. V.; Pohl, H. J.; Richwizky, S. V.; Semenyuskin, I. N.; Foltin, I. Translated by J. L. Zygielbaum (Univ. of California Lawrence Radiation Lab., Berkeley), from Nucl. Instrum. Methods, 33: 339-40(1965). 7p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.10 fr $0.80 mf.

The equipment for testing the SKP-1 photomultiplier is shown and described. The coincidence rate between pulses of the photomultiplier and electric pulses after their synchronization by a synchronizing device, in relation to the delay (phase shift) of the UHF control voltage is given. Also shown is the coincidence rate in relation to the delay time of the UHF control voltage of one photomultiplier as compared with the second photomultiplier. (J.F.P.)

3346 SLOW NEUTRON CHOPPER-MONOCHROMATOR WITH CURVED SLITS. Zsigmond, Gy.; Bata, L.; Kisdi-Koszo, E. (Central Research Inst. for Physics, Budapest). Nucl. Instrum. Methods, 45: 255-60(1966).

The design of two choppers with curved slits built for operation in the range of thermal and cold neutron energies is given. Chopper I can be used as mechanical selector in the whole range of thermal and cold neutron energies with a transmitted energy range ± 60%, chopper II gives a well-monochromatized (±10%) neutron beam in the cold neutron energy range. (auth)

3347 LINEAR GATE AND INTEGRATOR. White, G. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods, 45: 270-4(1966). (AERE-R–5020).

A linear gate, one of whose outputs is proportional to the time integral of the input pulse, is described. The circuit is direct coupled throughout in order to eliminate the effects of count rate. The gate and analog input circuit have a rise-time of about 2 nsec and can be used over a very wide range of input pulse widths. (auth)

3348 CURRENT INTEGRATOR WITH AUTOMATIC PULSE HEIGHT ANALYZER DEAD TIME CORRECTION. Page, J. G. (Univ. of Texas, Austin). Nucl. Instrum. Methods, 45: 331-4(1966). (ORO–2972-2).

A current integrator (range 10^{-9} to 10^{-4} A) was designed which uses a signal from a pulse height analyzer (dead-time signal) to allow the measurement of charge only during the time when the analyzer is in a receptive state. This integrator has its usefulness in determining the number of events per unit of charge when a target is bombarded with beam of charged particles. (B.G.D.)

3349 SIMPLE PULSE GENERATOR FOR TESTING NUCLEAR PULSE COUNTING EQUIPMENT. Galloway, R. B. (Univ. of Edinburgh). Nucl. Instrum. Methods, 45: 355-6(1966).

A simple pulse generator is described which was designed for testing faulty circuits in nuclear pulse counting equipment. A detailed circuit description is presented. (B.G.D.)

3350 OBSERVATION OF THE THERMAL FLUCTUATIONS OF A GRAVITATIONAL-WAVE DETECTOR. Weber, J. (Univ. of Maryland, College Park). Phys. Rev. Lett., 17: 1228-30 (Dec. 12, 1966).

The operation of an apparatus to measure the Fourier transform of the Riemann curvature tensor at sensitivity limited by the thermal fluctuations is reported. The gravitational interaction drives a mechanical system which in turn is coupled to the electromagnetic field. Strains as small as a few parts in 10^{16} are observable for a compressional mode of a large cylinder. (auth)

3351 PROBLEMS INVOLVED IN REGULATION OF THE ACCELERATING POTENTIAL OF A HIGH-RESOLUTION ELECTRON MICROSCOPE. Izyurov, A. V.; Pogudina, R. V.; Polivanov, V. V. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 843-5(1966). (In Russian).

The problems encountered in attempting to regulate the 100–150 kV accelerating potential of a type EMV-150 electron microscope are discussed. The accelerating potential was developed with a high frequency oscillator and rectifier unit. Regulation was accomplished with the aid of a 1000:1 wire-wound voltage divider (not described), a battery-supplied reference voltage, and a dc amplifier (gain, 2500) which controlled the screen voltage of the oscillator tubes. Some possible sources of instability are enumerated and the contributions of some of them to the over-all instability are evaluated. It was found to be unnecessary to employ mercury-zinc cells for the reference voltage battery, selected manganese-zinc cells proving to be sufficiently stable. By using a direct coupled dc amplifier with compensation circuits in the first stage and regulated anode and heater supplies it was possible to achieve a 30 minute average drift of 3 ppm/min at 100 kV and 10 ppm/min at 150 kV. (JPRS)

3352 DECIMETRIC MULTIPLIER OF FREQUENCY IN A GAS DISCHARGE IN A HETEROGENEOUS ELECTRIC FIELD. Aleksandrov, B. A.; Brandt, A. A.; Tyagunov, A. V. Vestn. Moskov. Univ., Ser. III: Fiz. Astron., No. 4, 91(July-Aug. 1965). (In Russian).

The performance of a decimetric frequency multiplier in gas discharge between coatings of a cylindrical condenser with very different diameters were investigated. The different diameters caused a heterogeneous electric field. The frequency of the feed generator was 400 MHz. The investigation of the amplifier was made in neon, argon, and helium in a wide pressure interval. The harmonic output and the efficiency of the conversion depends on the gas used and the pressure. The best results were obtained with helium at pressure of 1 mm Hg. The discharge output of the second harmonic was 2.2 w and the third 0.55 w at conversion efficiencies of 5 and 13 db, respectively. (J.S.R.)

3353 SIGNAL TO NOISE RATIO IN NUCLEAR PULSE AMPLIFIERS WITH HIGH REPETITION RATES. Bertolaccini, M.; Bussolati, C.; Gatti, E. (Politecnico, Milan). Nucl. Instrum. Methods, 42: 286-90(July 1966).

A new method to improve the signal to noise ratio of bipolar output signals from nuclear pulse amplifiers is described. The method, which essentially consists in performing amplitude measurements both on the positive and negative part of the signal, allows an improvement in signal to noise ratio over the usual case in which only one amplitude measurement is performed. Noise figures, taking into account correlated noise, were calculated for different RC-RC and gaussian filter amplifiers. An optimum filter, under the condition of bipolarity and of a given resolving time, was calculated in the hypothesis of performing the double measurement. (auth)

3354 SYSTEM FOR INSERTING RADIOACTIVE SOURCES IN VACUUM. Biasi, P.; Maurenzig, P. R.; Sona, P. (Univ., Florence. INFN, Florence). Nucl. Instrum. Methods, 42: 305-6(July 1966).

A device which enables a quick insertion of radioactive sources in a vacuum chamber is described. It was designed for a vacuum chamber used for beta and gamma spectroscopy with cooled semiconductor detectors. (B.G.D.)

3355 FAST LIGHT PULSER USING A HYDROGEN THYRATRON. Tawara, H. (Hitachi Ltd., Japan). Nucl. Instrum. Methods, 42: 318-20(July 1966).

A light pulse generator utilizing the commercially available hydrogen thyratron 1G45p or 3C45 is described. (B.G.D.)

3356 SUPERCONDUCTING LENS FOR ELECTRON MICROSCOPY. Kitamura, Norihisa; Schulhof, Michael P.; Siegel, Benjamin M. (Cornell Univ., Ithaca, N. Y.). Appl. Phys. Lett., 9: 377-80(Nov. 15, 1966).

Arrangements of superconducting materials were investigated to obtain objective lenses with the lowest possible spherical aberration coefficient (C_s) for the electron microscope. Various configurations of Nb_3Sn in ferromagnetic containers giving current loops of small radii which produce axially symmetric magnetic fields with high peak intensities and narrow halfwidths were studied. The axial field distributions were measured (bismuth probe) and optical parameters and spherical aberration coefficients were calculated. Available superconducting materials appear to set a limit of $C_s \simeq 0.4$ and 1.8 mm for 100-kV and 1000-kV electrons, respectively (bore dia. 5 mm). (auth)

3357 A 100 Mc/s 2 OUT OF 3 GATE. Whittaker, J. K. (National Bureau of Standards, Washington, D. C.). Nucl. Instrum. Methods, 45: 138-40(Nov.-Dec. 1966).

A direct-coupled gate to determine when any two out of three inputs are present is described. The gate will function up to at least 100 Mc/s and employs negative logic signals of nominal amplitude −1 V. (auth)

3358 DEVELOPMENT OF A MULTICHANNEL ANALYZER WITH LOW DEAD TIME. Gorodetzky, S.; Wendel, P.-L.; Ring, Ch.; Armbruster, R. (Centre de Recherches Nucleaires, Strasbourg). Nucl. Instrum. Methods, 45: 72-6(Nov.-Dec. 1966). (In French).

In order to know if it is possible to realize a parallel input multichannel pulse height analyzer with 50 channels, having a resolution time of 50 ns whatever the channel and a differential stability better than 10%, a single channel analyzer containing the essential elements of the multichannel analyzer was conceived. The described apparatus presents the following characteristics: max. input repetition rate: 20 Mc/sec; dynamic range: 200 mV at 2 v; threshold sensitivity and drift: 1 mv. (auth)

3359 HIGH-RESOLUTION ELECTRON MICROSCOPY WITH SUPERCONDUCTING LENSES AT LIQUID HELIUM TEMPERATURES. Fernandez-Moran, Humberto (Univ. of Chicago). Proc. Nat. Acad. Sci. U. S., 56: 801-8(Sept. 1966).

The design and operation of high-resolution cryo-electron microscopes using high-field Nb−Zr solenoid lenses with cryogenic specimen stage assemblies, pole pieces, and superconducting regulating circuitry are described. Exceptional long-term stability and high quality of electron microscopic images directly recorded at 200 to 20,000 × were demonstrated under carefully controlled conditions. The electron microscope operated in persistent current mode at 4 to 32 kG and 4 to 50 kv accelerating potential. Electron micrography of biological specimens were recorded at liquid helium temperatures of 4.2°K. Preliminary experiments demonstrated characteristic electron optical phenomena associated with trapped fluxes in thin superconducting films. (C.H.)

3360 AN APPROACH TO THE DESIGN OF RELIABLE RADIATION-HARDENED INTEGRATED LOGIC AND SEQUENTIAL CIRCUITS. Maurer, Harold Eugene. Lafayette, Ind., Purdue Univ., 1965. 212p.

Feasibility of the use of flashtube light sources to duplicate transient effects in integrated circuits produced by high energy electrons was demonstrated. Two flashtube pulsed light sources were designed, constructed and used to simulate the transient effect on exposed integrated circuits of a bombardment by 20 MeV electrons. The integrated circuits were Nor gates and sense amplifiers. Nor gates employed reverse-biased p-n junction isolation of components while the sense amplifiers employed both silicon dioxide and reverse-biased p-n junction isolation of components. The simulators produced good though not identical results especially near the thresholds of transient damage. Transient radiation effects equivalent circuits for integrated circuit Nor gates were derived. Equivalent circuits were derived for an integrated circuit Nor gate with reverse-biased p-n junction isolation of components and for an integrated circuit Nor gate with silicon dioxide isolation of components. Mathematical analysis and design procedure which produce reliable switching and computing circuits constructed of integrated Nor gates were developed. Design procedures were derived for a particular Nor gate with its individual, experimentally determined, radiation induced permanent damage failure criterion. The Nor gate failure criterion was determined experimentally. Other integrated circuit failure mechanisms were also investigated. Algorithms were derived for the generation of logic diagrams to realize given Boolean functions with Nor gate logic elements. Radiation hardening of these basic diagrams was also considered. Probabilistic models of the behavior of irredundant and redundant, radiation hardened Nor gates with permanent radiation-induced damage were derived. (F.S.)

3361 PROCEEDINGS OF THE NATIONAL ELECTRONICS CONFERENCE, VOLUME XXII, CHICAGO, ILLINOIS, OCTOBER 3, 4, AND 5, 1966. Chicago, National Electronics Conference, Inc., 1966. 1133p. $6.00. (CONF-661007).

Separate abstracts were prepared for 15 of the 227 papers presented at this conference. The remaining papers were not in the scope of NSA, and, hence, were omitted. (J.H.M.)

For abstracts of individual papers see: 3279–3282, 3365, 3471, 3472, 3642, 3643, 3756, 3812, 3832, 3851, 4168, and 4169.

3362 APPARATUS FOR DETECTING DIFFERENTIAL MOVEMENT. Jeffries, Thomas Oliver (to English Electric Co. Ltd.). British Patent 1,048,423. Nov. 16, 1966. Filed Aug. 23, 1963.

An apparatus is described which is used in detecting differential movement between at least one of a group of movable units and the remainder of the group. Independent movement of one or more of the units or a difference in the speed of movement in two units is detectable. The apparatus is useful in detecting movement of the control rods in a reactor core; when one rod moves independently of the other rods, an alarm is given on a warning device. The apparatus consists of a radiation source, a radiation sensitive means for supplying an output responsive to the intensity of the radiation in the beam, and rotatable perforated discs to scan movement. (F.S.)

3363 OPTICAL DELAY SYSTEM FOR PROVIDING EYE PROTECTION AGAINST INTENSE LIGHT. Kohler, Hans W. (to U. S. Army). U. S. Patent 3,273.458. Sept. 20, 1966. Filed Sept. 28, 1964.

An electro−optical system, in combination with an optical viewing device, protects an observer against harmful or blinding effects of intense light produced by laser beams or nuclear explosions. An optical delay means is used in an optical device to provide a time delay in the transmission of light from the objective lens to the eyepiece. An optical shutter between the optical delay and the eyepiece closes when the light intensity impinging on the objective lens exceeds a predetermined maximum. (F.S.)

3364 H.F. MASS SPECTROMETER WITH AN ELECTRON BOMBARDMENT ION SOURCE. Tretner, Werner (to Fernseh GmbH). German Patent 1,225,897. Sept. 29, 1966. Filed June 13, 1958.

A mass spectrometer is described which consists of a discharge tube, an analyzing electrode system disposed in the middle portion of the tube and composed of coaxially arranged and axially spaced cylindrical electrodes of different length whereby short ring electrodes are disposed between longer electrode cylinders, collecting electrodes at the ends of the tube for the collection of the ions, and a hot cathode adjacent to one of the collector electrodes with two flat grids on opposite sides which define the ionization volume. The electrode system is arranged and energized in such a way that two symmetrical immersion lenses are obtained along the axis, the refractive power of them being adjusted in such a way that the neighborhood of the two collecting electrodes is focused upon each other, the magnification being unity. (Gmelin Inst.)

Radiation Effects on Instruments and Instrument Components

3365 RADIATION-RESISTANT LOGIC CIRCUITS. Hampel, D. (RCA Advanced Communications Lab., New York). pp 737-42 of Proceedings of the National Electronics Conference. Vol. XXII. Chicago, National Electronics Conference, Inc., 1966.

Two general types of high-speed magnetic logic circuits for use in high nuclear radiation environments were discussed: the magnetic-tunnel rectifier and the tunnel diode-magnetic circuits. (B.G.D.)

3366 SPACE CHARGES IN IRRADIATED INSULATORS. Asch, Georges; Felix, Marie-Claude; Ongaro, Roger (Faculte

des Sciences, Lyon). Ind. At., 10: No. 9-10, 79-86(1966). (In French).

The various processes for forming space charges in irradiated insulators are reviewed: accumulation of charges by electronic bombardment, mobilization of electrons by the Compton effect along the lines of a single-direction γ radiation, segregation of the free carriers under the influence of an electric field applied simultaneously or subsequently to the irradiation. The principal characteristics of the space charges formed in this way are described: dissemination in space, stability, and influence of the dose. The theories interpreting the phenomena are briefly sketched. (auth)

3367 SUMMARY OF DIODE AND TRANSISTOR RESPONSE TO IONIZING RADIATION. Rogers, S. C. (Bell Telephone Lab., Inc., Whippany, N. J.). Bell Telephone Syst. Tech. Publ. Monograph 5171, 9p.(1966).

Irradiation of a semiconductor device with ionizing radiation causes ionization and excitation of electrons and the generation of hole electron pairs in the device. These hole electron pairs are free to move under the influence of such local environments as electric, magnetic, or diffusion fields. If any of these carriers traverse a junction before they recombine, a radiation-induced current (photocurrent) will flow at the device terminals. Some theoretical and practical consequences of these phenomena are reviewed to help the design engineer properly view the problems associated with radiation-induced transients in transistors and diodes. The phenomena are described qualitatively in terms of carrier generation and movement and described quantitatively by theoretical models for the responses of diodes and transistors. Practical aspects of predicting response of transistors imbedded in discrete component circuits are discussed and some studies pertaining to the response of monolithic integrated circuits are reviewed. Although the device models are generally accurate enough for radiation effects studies, the determination of the model parameters is difficult and time consuming. Furthermore, the computer programs that must be used to solve for response are limited by their speed, stability considerations, and nonlinear restrictions. In addition, electronic technology is moving in a direction that makes the prediction problem even more complicated; monolithic microcircuits are an example of this. For these devices, the geometry of conduction paths caused by ionizing radiation is clearly three-dimensional. This can be approximated by networks consisting of many loops; however, these additional loops are difficult to specify quantitatively, and the computer is burdened with additional equations which may require significant computing time for solving. Predictions of transistor and circuit response can now be made over a moderate range of radiation intensities with reasonable accuracy. (BBB)

3368 PLANAR-TRANSISTOR STABILITY UNDER X RAY IRRADIATION. Andre, B.; Buxo, J.; Esteve, D.; Martinot, H.; Simonne, J. (Univ., Toulouse). Electron. Lett., 2: 423-5(Nov. 1966). (In French).

Experiments on planar transistors irradiated by x rays show drifts of variable importance, according to the type of transistor (p-n-p or n-p-n). As an interpretation of the results, a surface-characteristic modification of the e-b diode due to the presence of a silicon-surface-induced charge density is proposed. (tr-auth)

3369 CHANGE OF THE CONCENTRATION AND MOBILITY OF CHARGE CARRIERS IN GaAs ON IRRADIATION WITH PROTONS. Wohlleben, K.; Beck, W. (Siemens-Schuckertwerke AG, Erlangen, Ger.). Z. Naturforsch., 21a: 1057-71(July 1966). (In German).

By measurement of the conductivity and the Hall effect, the decrease of the concentration and the mobility of the charge carrier in n- and p-GaAs in irradiation with 3 MeV protons was investigated. The dependence on the irradiation dose and on the initial doping ($n_0 = 5 \times 10^{15}$ to 3×10^{18} cm^{-3}, $p_0 = 2 \times 10^{17}$ to 8×10^{18} cm^{-3}) was measured. The carrier annihilation was strongly dependent on the site of the Fermi level and on the preliminary irradiation. The smallest measurable concentration was $n \approx 10^9$ cm^{-3} and $p \approx 10^{10}$ cm^{-3}, corresponding to a conductivity of $10^{-7}\Omega^{-1}$cm^{-1}. This measurement limit was measured by conducting surface layers. The extrapolation of the measurement results leads to expectation that under continued irradiation, the carrier concentration of p-GaAs (Cd doped) approaches a limiting value $p^* \approx 1 \times 10^9$ cm^{-3} and that n-GaAs converges to p-GaAs and attains the same limiting value ($E_F \approx E_V +$ 0.58 ev). The electron mobility decreases monotonously to about 10^{-2} of the initial value. The vacancy mobility passes through a minimum. As the analysis of the results shows, both donators and acceptors must be produced by irradiation in GaAs, that is, in a distribution, quasi-continuously within about 0.1 eV, whereby this distribution at times from the adjacent band edge reaches a distance of at least 0.50 eV from it. (tr-auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

3370 (AWRE-O-37/66) THE IN VITRO DISTRIBUTION OF PLUTONIUM AND AMERICIUM IN BLOOD SERUM. Boocock, G.; Popplewell, D. S. (Atomic Weapons Research Establishment, Aldermaston (England)). June 1966. 20p. Dep. mn. BIS $0.60. HMSO 3s.0d.

The binding of plutonium by transferrin has been demonstrated, whether the reaction is in vitro or in vivo. The binding of americium by serum proteins shows marked differences to plutonium binding. Distribution studies of the two actinides have been made between the protein and the non-protein components of sera. The effects of citrate ions on this distribution have been observed. (auth)

3371 (UCRL-16806) CHEMICAL BIODYNAMICS ANNUAL REPORT, 1965. (California Univ., Berkeley. Lawrence Radiation Lab.). Mar. 1966. Contract W-7405-eng-48. 73p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Separate abstracts were prepared for 17 sections of this report. A list is included of 41 publications issued during 1965. (C.H.)

For abstracts of individual sections see: 2937, 3175, 3372–3379, 3395, 3416, 4149, and 4429–4432.

3372 (UCRL-16806, pp 1-2) ORGANIZATION AND FUNCTION OF CHLOROPHYLL PIGMENTS IN PLANT CHLOROPLASTS. Sauer, Kenneth (California Univ., Berkeley. Lawrence Radiation Lab.).

Chlorophyll plays a unique role in nature as the essential catalyst for storing light energy in chemical products of high potential available for photosynthesis. The detailed mechanism of the role of chlorophyll in this process is largely unknown, but it is thought to depend critically on the specific environment and arrangement of the pigment molecules in the chloroplast. The nature of the phenomenon was investigated by kinetic measurements of the light reactions associated with photosynthesis and through physical measurements which will clarify the spatial organization of the molecules. Results showed that the photoreduction of the endogenous cofactor NADP (nicotinamide adenine dinucleotide phosphate) by chloroplasts occurs with a requirement of 2 to 4 quanta per electron transferred to NADP at wavelengths from 550 to 730 mμ in a system in which oxygen evolution is inhibited and electrons are furnished by reduced $DPIPH_2$ (2,6-dichlorophenolindophenol). The chloroplast-catalyzed photoreduction of cytochrome c, with reduced trimethyl-p-benzoquinone used as electron donor, occurs with a similar action spectrum but with requirements of only 2 quanta per electron at wavelengths from 620 to 680 mμ and 1 quantum per electron at longer wavelengths (700 to 740 mμ). On the other hand, reactions using water as electron donor and giving rise to molecular oxygen show different action spectra. Quantum requirements are similar (2 to 4 quanta per electron) in the 620- to 680-mμ region, but rise to values in excess of 20 at wavelengths longer than 700 mμ. This is true whether the electron acceptor is the endogenous NADP or Hill oxidants such as ferricyanide or oxidized DPIP. The results are interpreted as reflecting the participation of two pigment systems and two light reactions in the normal reduction of NADP using water and generating molecular oxygen. Optical studies on the chloroplast lamellae also produced evidence confirming the ordered nature of the pigment molecules. (C.H.)

3373 (UCRL-16806, pp 3-4) ROLE OF BACTERIOCHLOROPHYLL IN PHOTOSYNTHETIC HYDROGEN TRANSFER. Byrn, Marianne; Calvin, Melvin (California Univ., Berkeley. Lawrence Radiation Lab.).

Some of the chemical mechanisms that have been proposed for the participation of chlorophyll as a hydrogen transfer agent in the water-splitting reaction during photosynthesis are reviewed. Results are reported from a preliminary experiment using illuminated suspensions of bacteriochlorophyll from Rhodospirillum with tritiated water added. Results showed that about 2% of the bacteriochlorophyll molecules had incorporated tritium and that from 62 to 96% of the incorporated radioactivity was in the C3 and C4 positions. It was concluded that this represented a new bacteriochlorophyll synthesis. (C.H.)

3374 (UCRL-16806, pp 5) STRUCTURES OF RIBONUCLEIC ACIDS. Tinoco, I. Jr.; Bush, C. A.; Cantor, C. R.; Jaskunas, S. R.; Warshaw, M. M. (California Univ., Berkeley. Lawrence Radiation Lab.).

Results from measurements of the optical rotation and absorption of 16 dinucleoside phosphates containing adenine, cytosine, guanine, and uracil, of polyadenylic acid; and of the ribonucleic acid from tobacco mosaic virus were used to study helix formation in nucleic acids. Applications of the data gained from studies of the structures and properties of the dinucleosides and the interactions between the bases, which are first manifested in the dinucleosides, are discussed. (C.H.)

3375 (UCRL-16806, pp 6-8) APPLICATIONS OF ESR, MOESSBAUER, ELECTRONIC, AND OPTICAL ROTATORY SPECTRA TO PROBLEMS IN BIOLOGY. Klein, Melvin P. (California Univ., Berkeley. Lawrence Radiation Lab.).

Applications of a variety of spectroscopic techniques in studies of intact biological systems, component parts of such systems, individual molecules, and model systems to relate structural parameters and details to biological function are discussed. Examples described include studies of electron spin resonance (ESR) signals that occur when photosynthetic materials from Rhodospirillum are illuminated by light; the ESR spectra of complexes between porphyrins and metal ions occurring in biological materials; the Moessbauer spectrum of dilute samples of ferrichrome A; electron spectroscopic studies of sulfur in a number of proteins to elucidate sulfur bonding that affects the structural integrity of proteins; and measurements of the optical rotary spectra of a number of aromatic hydrocarbons at temperatures down to 200°K. The use of computers for the analysis of spectroscopic data is discussed. (C.H.)

3376 (UCRL-16806, pp 9-14) THE EFFECTS OF DAY LENGTH ON QUANTASOME STRUCTURE AND CHLOROPLAST PHOTOCHEMISTRY IN SPINACIA OLERACEA L. VAR. EARLY HYBRID NO. 7. Park, Roderic B.; Drury, Susan (California Univ., Berkeley. Lawrence Radiation Lab.).

Morphological studies of chloroplast fine structure show that to a first approximation the internal structure of a chloroplast consists of two phases. One phase is the internal membrane system and the second phase is the embedding matrix or stroma material of the chloroplast. The chemical processes of photosynthesis are distributed between these two phases. The light reactions and associated electron transport reactions are located in the internal membrane system. Here light is absorbed and converted to chemical potential. The chemical potential brings about electron transport from water to ferredoxin and is accompanied by photosynthetic phosphorylation. The CO_2 fixation enzymes of the carbon cycle, along with ribosomes and other soluble enzymes, are located in the stroma regions of the chloroplast. A simplified scheme demonstrating the role of these two phases in the photosynthetic process is presented. Preliminary results are reported from studies of the effects of photoperiod on the efficiency and internal structure of chloroplast membranes in Spinacia. (C.H.)

3377 (UCRL-16806, pp 17-24) EFFECT OF HYDROLYTIC ENZYMES ON THE PHOTOSYNTHETIC EFFICIENCY AND MORPHOLOGY OF CHLOROPLASTS. Bamberger, Elchanan S.; Park, Roderic B. (California Univ., Berkeley. Lawrence Radiation Lab.).

Progress is reported on studies of the relation between energy conversion processes during photosynthesis and the structure of internal membranes of chloroplasts. The chemical composition of the thylakoids, or internal membranes of chloroplasts was determined to be about 50% protein and 50% lipid. Results are reported from studies on the effects of two hydrolytic enzymes, lipase and protease, on the structure and function of isolated thylakoids from spinach leaf chloroplasts. The results were used to help determine the chemical compositions of the chloroplast membranes. (C.H.)

3378 (UCRL-16806, pp 31) BIOSYNTHESIS OF OPIUM AND TOBACCO ALKALOIDS. Rapoport, H. (California Univ., Berkeley. Lawrence Radiation Lab.).

Progress is reported on studies of opium alkaloid biochemistry. Emphasis was placed on the role of reticuline as a precursor and the role of thebaine in metabolism in poppy plants. Specifically labeled thebaine (C-14) was prepared for use in the studies. The biosynthesis of nicotine in Nicotiana plants was studied using $^{14}CO_2$ as a tracer. (C.H.)

3379 (UCRL-16806, pp 32-3) CATABOLITE REPRESSION OF ENZYME SYNTHESIS. Moses, V.; Prevost, C. (California Univ., Berkeley. Lawrence Radiation Lab.).

Results are reported from studies on the repression by glucose of β-galactosidase formation in E. coli in which ^{32}P-phosphate, ^{14}C-glucose, and ^{14}C-glucosine were used as tracers. (C.H.)

3380 DISTRIBUTION OF ^{32}P-ZIRCONYL COLLOIDAL PHOSPHATE IN THE TISSUES AND ITS INFLUENCE OF HEMATOPOIESIS. Khanykova, O. K.; Reshchikov, V. P.; Gerasimato, L. F. Med. Radiol., 11: No. 9, 30-6(Sept. 1966). (In Russian).

Distribution of a new radioactive colloidal preparation of phosphorus-32-labeled zirconyl phosphate with low toxicity was studied in mice. Phosphorus-32 was localized primarily in reticuloendothelial tissues. Administration of 10 to 20 μc of the preparation inhibited hematopoiesis and reduced the total leukocyte count. Hematopoietic recovery was relatively prompt. (H.G.D.)

3381 BIOSYNTHESIS OF DEUTERATED ISOPEROXIDASES IN RYE PLANTS GROWN IN D_2O. Siegel, B. Z.; Galston, A. W. (Yale Univ., New Haven). Proc. Nat. Acad. Sci. U. S., 56: 1040-2(Sept. 1966).

Winter rye seeds germinated in 99.77% D_2O contained six isoperoxidases similar to those found in control seeds germinated in H_2O. Five of these isoperoxidases from those grown in D_2O were shown to be deuterated and it was concluded they were synthesized during germination. (C.H.)

3382 INDUCTION OF CELLULAR DNA SYNTHESIS BY SIMIAN VIRUS 40 IN CONTACT-INHIBITED AND IN X-IRRADIATED CELLS. Gershon, David; Sachs, Leo; Winocour, Ernest (Weizmann Inst. of Science, Rehovoth, Israel). Proc. Nat. Acad. Sci. U. S., 56: 918-25(Sept. 1966).

Simian virus 40 induced the synthesis of cellular DNA in contact-inhibited and in x irradiated cultured mouse cells at high multiplicity of infection. No induction of cellular DNA synthesis was detected in contact-inhibited or x irradiated cultured monkey cells after virus infection at either high or low multiplicity. (C.H.)

3383 RADIOBIOASSAY FOR STAPHYLOCOCCAL ENTEROTOXIN B ANTITOXIN. Hodoval, Leland F.; Rapoport, Morton I.; Beisel, William R. (Army Medical Univ., Fort Detrick, Md.). J. Lab. Clin. Med., 68: 678-85(Oct. 1966).

The half disappearance time (t $\frac{1}{2}$) of highly purified, ^{131}I-labeled staphylococcal enterotoxin B (SEB-^{131}I) from the blood of male albino rats was studied as a means for the assay of specific staphylococcal enterotoxin B antisera (SEBA). A prolongation of the half disappearance time of SEB-^{131}I resulted when specific antiserum was used for passive immunization of rats. The length of prolongation was proportional to the concentration of antisera used. A standard volume of specific SEBA (equine origin) was administered intravenously prior to a constant intravenous dosage of SEB-^{131}I. The radioactivity of whole blood was measured serially, and a linear semilogarithmic disappearance curve was used to calculate t $\frac{1}{2}$ and various dilutions of SEBA were used to study the change in t $\frac{1}{2}$. The assay appeared to be specific as evidenced by studies of human gamma globulin, human sera with and without staphylococcal hemagglutination titers, hyperimmune and nonimmune burro sera, nonimmune guinea pig sera, nonimmune monkey sera, saline, and heparin. (auth)

3384 IN VITRO DNA LABELING OF BONE MARROW AND LEUKEMIC BLOOD LEUKOCYTES WITH TRITIATED THYMIDINE. II. ^{3}H THYMIDINE BIOCHEMISTRY IN VITRO. Rubini, Joseph R. (Univ. of Miami, Coral Gables, Fla. Veterans Administration Hospital, Coral Gables, Fla.). J. Lab. Clin. Med., 68: 566-76(Oct. 1966).

The metabolism of ^{3}H thymidine (^{3}HTDR) was studied during its incubation with normal canine marrow cells and some other tissues. Quantitative utilization of ^{3}HTDR for new DNA synthesis was shown to be minimal; more than 90 per cent of the added ^{3}H activity remained in the cell free supernatants. Labeled DNA synthesis was shown to occur rapidly but briefly. Analyses of the supernatants during the in vitro labeling of the marrow cells demonstrated rapid degradation of most of the ^{3}HTDR to ^{3}H thymine because of the intracellular enzyme TDR phosphorylase. Enhanced ^{3}HTDR utilization for ^{3}HDNA synthesis could be obtained by blocking TDR phosphorylase with added nonradioactive thymine and some related compounds. Efforts to achieve greater ^{3}HDNA synthesis from ^{3}HTDR are reported. (auth)

3385 BINDING OF CALCIUM, YTTRIUM, AND THORIUM TO A GLYCOPROTEIN FROM BOVINE CORTICAL BONE. Peacocke, A. R.; Williams, P. A. (Oxford Univ.). Nature, 211: 1140-1 (Sept. 10, 1966).

Binding of bone-seeking metal ions to sialoprotein extracted from bone is reported. The titration curves of bone sialoprotein were determined in the presence of increasing concentrations of yttrium chloride and at one concentration of calcium chloride. Binding of Y and Ca were dependent on pH. Almost the same curves were obtained with Ca at a total concentration of 40 mM as with Y at a total concentration of 0.1 mM. Results suggest that bone sialoprotein is likely to contribute substantially to the uptake of those bone-seeking elements that are preferentially deposited at the resting and resorbing surfaces. (H.G.D.)

3386 KINETICS OF ^{32}P ACCUMULATION AND DETERMINATION OF THE DOSE IN THE BRAIN BY BREMSSTRAHLUNG. Belugina, Z. T.; Kachur, L. A.; Lapchenkov, V. I. Med. Radiol., 11: No. 9, 16-20(Sept. 1966). (In Russian).

Phosphorus-32 uptake by the brain was studied in 18 polycythemia patients who were given therapeutic doses of radiophosphorus. Absorbed doses in brain phantoms were determined by bremsstrahlung detection with a gamma spectrometer. Brain dose was approximately 20 to 30% of the liver dose in the same patient. Data were treated biometrically. (H.G.D.)

3387 SEROTONIN EXCHANGE IN CHRONIC RADIATION SICKNESS. Shchegoleva, R. A.; Nesterenko, A. I.; Chernov, G. A. Med. Radiol., 11: No. 9, 58-60(Sept. 1966). (In Russian).

The exchange of serotonin in chronic irradiation was studied in dogs. For the characterization of the serotonin exchange, a dynamic determination of the serotonin level in the blood, 5-oxyindolacetic acid in the urine, and the activity of ceruloplasmin in the blood serum were determined at different times post-irradiation. The results demonstrate that the exchange of serotonin is disturbed by chronic irradiation, phasic changes of the serotonin level appearing at early periods after the beginning of irradiation. Changes in the level of 5-oxyindolacetic acid in the urine and ceruloplasmin activity are correlated with alterations of the serotonin level in the blood. (auth)

3388 ON THE ACTION OF X RAYS ON PHOTOSYNTHESIS AND PHOSPHATE METABOLISM OF UNICELLULAR GREEN ALGAE (ANKISTRODESMUS BRAUNII). Simonis, Wilhelm; Urbach, Dorothea (Univ., Wuerzburg, Ger.). Z. Pflanzenphysiol., 54: 321-32(Mar. 1966). (In German)

Effects of x radiation on photosynthesis and light-dependent phosphate metabolism were studied by measurement of O_2 evolution, short-time incorporation of ^{32}P in the trichloroacetic acid (TCA)-soluble organic phosphate fraction, and $^{14}CO_2$ fixation. As with earlier results on isolated chloroplasts, O_2 evolution proved to be exceedingly radioresistant. The fixation of $^{14}CO_2$ was also impaired only by high doses (above 250 krad). In contrast, ^{32}P incorporation in the TCA-soluble fraction in the light proved to be considerably more sensitive to x rays, a dose as low as 6 krad, than photophosphorylation in isolated chloroplasts. The ^{32}P incorporation in dark was less inhibited than in the light. Only at very high doses could destruction of chlorophyll be detected so this cannot provide an explanation for these actions of x rays. The effect of x irradiation on O_2 evolution did not change with time up to 6 hr after the irradiation. The destruction of chlorophyll, however, increased with time after irradiation, and was enhanced by light. These results cannot be analyzed in relation to those from isolated chloroplasts by solely assuming an uncoupling of the photosynthetic phosphorylation by low doses, because the $^{14}CO_2$ fixation exhibited a similarly high radioresistance to O_2 evolution under the conditions of the experiments. An uncoupling of photosynthetic phosphorylation should diminish the formation of $^{14}CO_2$-labeled photosynthetic intermediates at a correspondingly low dose. Since light-dependent phosphorylation is affected by smaller doses than the dark phosphorylation, a working hypothesis is proposed that x rays affect the $^{32}PO_4$ incorporation, by an action on transport through intracellular membranes. The rate-limiting process in $^{32}PO_4$ incorporation is presumably inhibited transport at chloroplast membranes in the light or at the mitochondrial membranes in the dark. (TCO)

3389 BEHAVIOR OF ^{137}Cs IN SOILS AND PASTURES: A LONG TERM EXPERIMENT. Squire, H. M.; Middleton, L. J. (Agricultural Research Council, Wantage, Eng.). Radiat. Bot., 6: 413-23(Oct. 1966).

The movement of ^{137}Cs in soil and its absorption by ryegrass have been studied over a period of 6 years and compared with that of ^{90}Sr. Carrier-free nuclides were added to the surface of 4 soils which contrasted in their content of exchangeable cations and clay and exposed to natural weather conditions. The downward movement of ^{137}Cs was greatest in a calcareous soil which contained over 25 m-equiv./100 g exchangeable cations and least in a soil with a high clay content; after 6 years the median depth ranged from 1 to 3 cm. The corresponding values for ^{90}Sr were 3 and 5 cm respectively. As with ^{90}Sr the movement of ^{137}Cs was unaffected by cropping with ryegrass but unlike ^{90}Sr the annual additions of fertilizer to all four soils were without effect. During the first 3 years of the experiment the absorption of ^{137}Cs by ryegrass decreased by factors ranging from 5 to 40, the decrease being greatest from the soil with the highest clay content and least from the most sandy soil. It was thought to be caused by the progressive

fixation of ^{137}Cs on clay minerals. This fixation appeared to be largely complete 3 years after contamination since the ^{137}Cs content of grass decreased thereafter by only about 30 per cent. The absorption of ^{137}Cs was also influenced by the concentration of exchangeable potassium in the soils. The ^{137}Cs content of grass grown on the soil with the lowest exchangeable potassium and the lowest clay content was some 10 times greater than that from the soil with the highest potassium content. From all soils the amount of ^{137}Cs absorbed was much less than that of ^{90}Sr and the ratio in which the two nuclides were absorbed decreased with time. In the first year the ratio of ^{137}Cs absorption to that of ^{90}Sr ranged from 0.04 to 0.2 whilst corresponding values in the fifth year were 0.01 and 0.04. (auth)

3390 EFFECTS OF IONIZING RADIATION ON PROTEIN COMPOUNDS AND TANNED SKIN. Strakhov, I. P.; Shifrin, I. G. Nauch. Tr. Moskov. Tekhnol. Inst. Legkoi Prom., No. 30, 34-47 (1964). (In Russian).

Effects of low γ-radiation doses on chrome-tanned and oil-tanned leather was studied using Russian leather and chrome-oil tanned specimens irradiated with 1.5×10^4, 0.5×10^5, and 10^5 rad doses. Results showed that following irradiation the leather compression temperature increased from 2 to 4° and for some specimens from 5 to 7°. The tensile strength of the top leather was reduced by 2 to 4%, while the tensile strength of the sole leather irradiated with 1.5×10^4 rad, 0.5×10^5 rad, and 10^5 rad was reduced 21, 25, and 16%, respectively. Additional tests indicated from 5.3 to 31% better service from irradiated chrome-tanned samples and up to 52% better service from specimens of oil-tanned leather irradiated with 10^5 rad. (R.V.J.)

3391 THE PHYSIOLOGICAL BASIS OF THE USE OF ^{86}Rb TO MEASURE RENAL BLOOD FLOW BY EXTERNAL SCINTILLATION COUNTING. Blandy, J. P.; Sear, R.; Wilks, R. (London Hospital). Brit. J. Urol., 37: 499-506(Oct. 1965).

It was found by decay studies, which are described, that commercial samples of ^{86}Rb were contaminated by a long-lived material. Pulse height analysis revealed that this contaminant was ^{134}Cs. It was confirmed from the supplier that ^{134}Cs might be present in small amounts at the time of delivery. Because ^{134}Cs has a half-life of 2.2 yr (as compared with 18.6 days for ^{86}Rb) the content of this impurity would effectively double every 19 days. Moreover, ^{134}Cs has a much more prolific γ-ray emission per disintegration than ^{86}Rb. As a result, several weeks after delivery a substantial proportion of the total γ-ray emission (and hence the counts detected) could be coming from the Cs impurity. Dogs were used to examine the renal uptake of ^{134}Cs and ^{86}Rb. After intravenous injection, the rate of uptake of ^{86}Rb by the kidney was rapid, reaching a peak within two minutes, and thereafter falling off slowly. These results suggest that the tissue handling by the kidney of Rb in the dog is of the same order of rapidity as that observed in smaller animals for this element, and in both cat and dog for K. The rate of uptake is of such a rate as to give virtually complete uptake within one circulatory transit time. The early uptake of ^{134}Cs by the kidney was different from that of ^{86}Rb. The peak activity of ^{134}Cs was not reached until 15 to 20 minutes after injection. This relatively slow process may be dependent on factors other than the blood flow to the organ. Direct radioassay showed that ^{86}Rb is rapidly taken up by the kidney of the dog, and that between one and two min after injection there is a more than tenfold difference between the concentration in kidney and that in liver, muscle, or blood. $^{134}Cesium$ disappeared relatively slowly from the blood. These findings suggest that the renal uptake of ^{86}Rb in the dog follows the pattern of tissue uptake previously observed in the dog for K and in the rat for both K and Rb; i.e., there is a rapid uptake which is proportional to the renal flow. Methods are described in detail whereby identification of a ^{134}Cs impurity in commercial samples of ^{86}Rb can be detected. (BBB)

3392 STUDY OF THE THYROID FUNCTION WITH ^{125}I AND ^{132}I. Scheeper, J. H. (Univ., Utrecht). Jaarb. Kankeronderz. Kankerbestrijding Ned., 14: 301-2(1964). (In Dutch).

The advantage of ^{125}I in studies of thyroid function is the low energy of emitted γ radiation; the advantage of ^{132}I is its short half life (2.3 hours). Both isotopes are administered simultaneously; after 5 hours, uptake in the thyroid is measured and the ratio determined, in order to correct the figures for decay of one isotope. Less than a third of the ^{131}I dose is needed for determination. For comparison, ^{131}I, 10 μC impart a mean dose of 18 rad to the thyroid, 0.006 rad to the whole body, and 0.0015 rad to the gonads in a euthyroid patient, 70 kg, 180 cm long; the values for sufficient testing with the combined isotopes are: ^{132}I, 10 μC, 0.2 rad to thyroid, 0.001 to whole body, 0.0015 to gonads; and ^{125}I, 5 to thyroid, 0.005 to whole body, 0.002 to gonads. Thus for the test the total doses are 5.2, 0.006, 0.0017, respectively. Statistical methods and results with patients are discussed. (BBB)

3393 EXPERIMENT WITH A CONTROLLED INTAKE OF ^{137}Cs IN MAN. Lindblom, G. (Foersvarets Forskningsanstalt, Stockholm). 12p. (CONF-747-4). ORAU.

From 4th Symposium on Radioactivity in Scandinavia, Riso, Denmark, Oct. 1964.

The purpose of the experiment was to do a recalibration of the whole-body counter HUGO and to determine the biological half-life of ^{137}Cs in man. Some cross-checkings with other body counters have been carried out. The half-life turned out to be 115 days, which is considerably longer than indicated by results from measurements of "normal" body burdens and dietary intake in Sweden and Finland. The experiment also points out some difficulties involved in drawing conclusions about body burdens and biological half-lives from urinary analysis. Measurements of a small control group indicate minor changes in average body burden during the observation period May–Dec. 1964. (auth)

3394 PHAGOCYTOSIS OF COLLOIDAL THORIUM DIOXIDE AND COBALTIC OXIDE BY THE RETICULOENDOTHELIAL SYSTEM OF THE RAT. Kabisch, William T. (American Association for the Advancement of Science, Washington, D. C.). 30p. (CONF-660422-3). ORAU. Gmelin, AED-CONF-66-178-5.

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York.

Intravenous injections of Thorotrast in the form of a sterile stable colloidal suspension were given to young adult rats, and they were killed at certain intervals of time. The liver, spleen, lungs and other organs were removed and weighed. Urine and feces were collected. Tissue samples were fixed and stained for microscopic study, and tissues were ashed for radioassay. Results are tabulated. The relative phagocytic activities of liver, lungs and other organs are demonstrated. The liver as a total organ shows greater phagocytic activity than any other organ. As the dose increases, the spleen and lungs show an appreciable increase in their uptake. In terms of uptake per gram of tissue, the liver and spleen show about the same activity at low doses, but with increased dosage the spleen shows a sharp increase, while the liver reaches a plateau. Lung activity is negligible at low dose levels, but shows a sharp increase at high dose levels. The differences in ability of various organs to segregate particulate matter from the blood stream are discussed. Difficulties in using Thorotrast as an indicator of phagocytic activity are discussed. Splenectomy and hepatectomy were performed to alter the normal phagocytic potential. The hepatectomized rats showed a striking increase in the amount of material taken up by the spleen, lung, bone marrow and lymph nodes. Criteria for selection of a suitable phagocytic test substance are discussed, and black cobaltic oxide was chosen as the best material. Results of experiments using this material were in general very similar to results obtained with Thorotrast. (H.L.W.)

Genetics and Cytogenetics

3395 (UCRL-16806, pp 25-30) PHOTOSYNTHESIS OF CARBON COMPOUNDS. Bassham, J. A.; Kirk, Martha; Pedersen, T. A.; Jensen, Richard; Hetzer, C. N.; Gelb, Susan; Ng, Kam-sik (California Univ., Berkeley. Lawrence Radiation Lab.).

Progress is reported on studies of the photosynthesis of carbon compounds. Results are reported from studies on light-dark transient changes in the labeling of intermediate compounds in Chlorella and isolated spinach chloroplasts in the presence of ^{32}P-phosphate and $^{14}CO_2$. (C.H.)

3396 X-RAY-INDUCED REVERSION OF THE WHITE-IVORY MUTANT OF DROSOPHILA MELANOGASTER. Bowman, James T. Jr.; Green, M. M. (Utah State Univ., Logan. Univ. of California, Davis). Genetica, 37: 7-16(1966).

Following x irradiation, w^1 reverts in oogonia and in spermatogonia. Following treatment of adult females, w^1 reverts equally frequently in homozygotes and deficiency heterozygotes. Induced reversions are commonly recovered as clusters, indicating that they are of gonial origin. In contrast to w^1, two partial reversions recombine normally with w^{ch}. One of these has been tested for x-ray-induced reversion and found to be stable. (auth)

3397 ON POST IRRADIATION MODIFICATION OF BIOLOGICAL EFFECTS OF NEUTRONS. II. EFFECT OF 5-FLUORODEOXYURIDINE ON CHROMOSOMAL ABERRATIONS IN NEUTRON IRRADIATED SEEDS. Moutschen-Dahmen, M.; Moutschen, J.; Ehrenberg, L. (Univ., Liege. Univ. of Stockholm). Radiat. Bot., 6: 425-31(Oct. 1966).

Fast-neutron-irradiated barley and Vicia seeds were treated with 5-fluorodeoxyuridine (FUDR) at a concentration below that at which cytological disturbances are produced by FUDR alone. In Vicia, FUDR produced an increase of chromosome breaks (chiefly isolocus breaks) at all doses (40-300 rad). Sister unions and

chromosome exchanges were decreased at high doses, and probably increased at low doses. The frequencies of minute deletions were increased at all doses. Corresponding effects were found in barley. The mutation rates studied in this material were not affected by FUDR. Especially with respect to the increased frequencies of breaks the action of FUDR is similar to that previously described for Myleran. The effect is discussed in view of a possible modification of the rejoining of radiation induced breaks. (auth)

3398 GENETICAL AND PHYSIOLOGICAL CAUSES OF THE VARIATION OF RADIOSENSITIVITY IN BARLEY AND MAIZE. Stoilov, M.; Jansson, G.; Eriksson, G.; Ehrenberg, L. (Univ. of Stockholm. Inst. of Plant Breeding, Sofia). Radiat. Bot., 6: 457-67(Oct. 1966).

In a few experiments in barley and maize inherited factors influencing the radiosensitivity were studied. The Bulgarian barley variety No. 1337 was found to be much less radiosensitive, with respect to seedling growth reduction following γ-irradiation of seeds, than the Swedish variety No. 02104. Following neutron irradiation, following storage of γ-irradiated dry seeds, or following γ-irradiation of pre-soaked seeds, the difference between the two varieties was appreciably smaller. The difference is thus consistent with a lower oxygen concentration in the seeds of No. 1337. A certain (negative) correlation was established between "water-sensitivity" of barley seeds and their sensitivity to γ-radiation. Seeds of inbred lines and hybrids of maize exhibited characteristic variations of the radiosensitivity with respect to seedling growth inhibition. Two single crossed hybrids and their double cross were less sensitive to γ-radiation as well as neutrons than their four parent inbred lines. These variations of radiosensitivity were not correlated to frequencies of neutron induced chromosomal aberrations. The lines differ in sensitivity with respect to mutation induction, however, one hybrid giving, compared to the parent lines, a 3-6 times lower frequency of "waxy" pollen grains after semi-chronic γ-irradiation during meiosis. The fast-growing inbred line Wf-9 was appreciably less sensitive than the others, with respect to seedling growth inhibition, chromosomal aberrations as well as mutation induction. When the complete germination inhibition induced by high doses (0.2–1 Mrad) was studied, the order of sensitivity of the lines became completely different, with no special resistance in the hybrids. The latter were somewhat superior, however, with respect to elongation of root cells in the surviving seeds. (auth)

3399 FERTILIZATION WITH IRRADIATED POLLEN IN TRADESCANTIA. Vassileva-Dryanovska, O. A. (Agricultural Coll. of Sweden, Uppsala). Radiat. Bot., 6: 469-79(Oct. 1966).

Flowers of diploid and tetraploid material of Tradescantia paludosa were pollinated with irradiated pollen. X-ray exposures of 1, 5, 10, 50 and 150 kR as well as gamma ray exposures of 500 kR from ^{60}Co were used. The flowers were fixed in Carnoy 1-56 hr and 3-15 days after pollination. At all the exposures studied the pollen was capable of germinating on the stigmas and the tubes were able to grow down to and penetrate the embryo sacs. In the pollen tube mitoses the following abnormalities were seen: chromosome stickiness, bridges and fragments. After exposures of 1-5 kR two sperm nuclei of equal or unequal size were formed, and these were not accompanied by fragments or connected by bridges. After exposures of 10-50 kR the sperm chromatin was highly variable and the following types were seen: undivided generative nuclei, two sperm nuclei of equal or unequal size with or without extra nuclear fragments and free or connected by bridges. After exposures of 150-500 kR undivided generative nuclei with or without nuclear fragments were found. The same types of nuclei were found in pollen tubes that had entered the embryo sac and their fusion with the female nuclei could be observed. Largely as a consequence of the differences in type of the male chromatin, the following different types of fertilization were observed. (a) Both the egg nucleus and the polar nuclei are fertilized by sperm chromatin from one or two pollen tubes. (b) Fertilization of only the egg nucleus or only the polar nuclei occurs, the other of these two kinds of female nuclei remaining unfertilized. The following types were observed with respect to nuclear fusion. (a) A normal fusion as in untreated material (1-500 kR). (b) Nuclear fusion occurs but the normal changes in chromatin structure of the zygote nucleus do not occur (150-500 kR). Most of these nuclei do not divide, but a few do. (c) Nuclear fusion does not occur but the male chromatin is appressed to the female nucleus, which may sometimes be stimulated to start DNA synthesis and division (150-500 kR). (auth)

3400 RADIATION-INDUCED VARIATION IN RAY-FLORET CHARACTERISTICS OF ANNUAL CHRYSANTHEMUM. Rana, R. S. (Indian Agricultural Research Inst., New Delhi). Euphytica, 14: 296-300(Nov. 1965).

Dry seeds of Chrysanthemum carinatum were subjected to an x-ray dose of 15 kR at an operating voltage of 50 kv and sown immediately. In the X_2 population, raised from seeds of the open-pollinated X_1 parents, four distinct mutants involving ray florets could be recognized. Another mutant type appeared in which the pistillate ray florets assumed the bisexual characteristic of the disc florets. Fertility of all the five mutant types was normal and their breeding behavior in subsequent generations showed that all were phenotypically stable with one exception. Recombination analysis showed that the induced bisexual characteristic of ray florets is determined by a single gene and is recessive to the pistillate nature. In the mutant with single type flowers having bisexual ray florets instead of the usual pistillate rays, this character, when introduced in the double types, can be extremely significant in ensuring a regular and abundant pollen supply among the doubles. Thus, some of the induced changes may directly form the basis for new strains while others can provide variation for further improvement work. (TCO)

3401 CHROMOSOME ABERRATIONS AFTER RADIUM–X-RAY THERAPY OF GYNECOLOGICAL TUMORS. Bauchinger, Manfred; Hug, Otto (Gesellschaft fuer Strahlenforschung, Munich. Univ., Munich). Strahlentherapie, 131: 109-21(Sept. 1966). (In German).

Chromosomes were investigated in 37 women with different genital carcinomas during or after a combined radium-x-ray therapy. Lymphocytes of the peripheral blood were analyzed using a standard blood culture method. Numerous and severe chromosome aberrations were observed in the white blood cells of all patients. In the average, 28% (maximum value 59.4%) of the modal N-cells were found to show changes. The cells analyzed are summarized in a table which is exclusively based on morphological criteria of the caryotype directly observed. Difficulties encountered in the determination of a dose-effect-relation for the chromosome aberrations as well as the relations between cytogenic changes and malignant radiation late effects are discussed. (auth)

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Refer also to abstracts 2935, 3181, 3253, 3309, 3310, and 3702

3402 (NP-16260) NEKOTORYE GIGIENICHESKIE ASPEKTY PROBLEMY ^{226}Ra. (Certain Hygienic Problems of ^{226}Ra). Marei, A. N.; Karmaeva, A. N. (Institut Atomnoi Energii, Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1965. 12p. Dep. mn.

A study of radium-226 was conducted in one of the large cities of Central Asia from 1961 to 1964. The following aspects of the study were included: seasonal variations of radium-226 concentration in drinking water; radium-226 content of water consumed by residents as a function of its origin; radium-226 content of 17 types of foods; daily intake of radium-226 by way of food; radium content of bone of residents by age group; content of certain other elements in well water and in the city water system; daily calcium intake for persons using water from different sources; radium content of bone of persons using water from different sources. In places of higher radium content the radium reaching the population via food was comparable to the amount received through the drinking water. When the calcium content of the diet was normal, the calcium in drinking water limited the accumulation of radium in human bone. (M.M.T.)

3403 (RM-5048-TAB) THE RELATIONSHIP BETWEEN POST-IRRADIATION RECOVERY AND EQUIVALENT RESIDUAL DOSE. OKunewick, James P. (RAND Corp., Santa Monica, Calif.). Oct. 1966. Contract AT(04-3)-414. 33p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The problem of estimating the equivalent residual dose (ERD) of radiation retained by a man or an animal at any particular time following exposure to ionizing radiation is reviewed to determine whether the principal existing model used for estimating ERD fits the most recent experimental data and would therefore be applicable to studies related to thermonuclear war. It has been noted that the most commonly utilized model was drawn from data which used as an end point life-shortening after prolonged exposure to low doses of irradiation. However, in view of the significant body of experimental data which does not fit the model, reason was found to question the applicability of this model except in certain limited cases. The relationship between the establishment of an ERD for men and animals at any specified time and the physiological mechanisms underlying radiosensitivity at that time is therefore examined in detail. It is shown that recovery of men and animals from doses between approximately 100 R and the $LD_{100/60}$ could be correlated with the effects on certain critical tissues, in particular, the blood-forming tissue. Recovery of this tissue was found to differ from that shown by the commonly accepted models for radiation recovery in that it was oscillatory and not exponential

in nature. Estimates of radiation sensitivity of the whole animal that are obtained from splitdose experiments carried out over several days parallel the recovery of this tissue. This fact is extremely important in that predictions of ERD values have been made using only one or two data points obtained from split-dose studies and assuming exponential recovery. The finding that recovery may be oscillatory rather than exponential means that estimates of the ERD made in this manner may be subject to significant errors. The evidence for and possible mechanisms involved in this oscillatory recovery are therefore reviewed in this Memorandum. The applicability of the present models is discussed, and some factors which must be considered in developing a generally applicable model for the representation of post-irradiation recovery in man and animals are listed. (auth)

3404 (TID-23390) NUCLEAR TRANSPORTATION. PART I. RESEARCH AND ITS COORDINATION. PART II. PROBLEMS ASSOCIATED WITH RESEARCH. Thompson, J. Trueman; Morgan, James M. Jr. (Johns Hopkins Univ., Baltimore, Md. Dept. of Environmental Engineering Science). Dec. 1965. Contract AT (30-1)-3503. 91p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

The scope and status of research in transportation of nuclear materials is covered as an evaluation of the overall program; strengths and weaknesses of the research effort are highlighted. Problems associated with research are mentioned as: the importance of nuclear transportation, modes of transportation, the relation of safety versus cost, insurance, the interrelated weight-cost problem, standardization-interchangeability, specialized transportation services, criticality control, relation with toll and other transportation groups, and the development of regulations. Appendices discuss the possible role of a coordinator of transportation research and a data-bank information retrieval system. Recommendations and conclusions are made. (auth)

3405 CONTAMINATION AND DECONTAMINATION PROPERTIES OF EPOXIDE PAINTS AND LACQUERS. Rotrekl, Bedrich (Research Inst. for Synthetic Resins and Lacquers, Pardubice, Czech.). Jad. Energ., 12: 222(June 1966). (In Czech).

Epoxide paints and lacquers developed at the Institute are discussed; special hardeners that reduce adsorption of radioactive isotopes and produce a hydrophobic surface are described. The surface of the paint was contaminated with ^{90}Sr, ^{90}Y, ^{32}P, and ^{137}Cs; decontamination by means of hydrochloric and citric acid solutions is described. The mechanism of adsorption on the surface of epoxide resins by means of ion exchange is discussed. Suitable compositions of decontaminating solutions are described. (JPRS)

3406 DEVELOPMENT OF THE RADIATION-PROTECTION ORGANIZATION AS MIRRORED BY RECENT LEGAL REGULATIONS. Bonta, Janos. Atomtech. Tajek., 9: 199-205(1966). (In Hungarian)

During the past few years several important radiation-protection regulations were issued in Hungary. The 1964 decrees and ordinance on radioactive preparations and the monitoring of the health of workers exposed to radiation established the legal basis for a formal radiation-protection organization in all areas of national economy that relate to radioactive materials. Appendixes to these basic decrees list the materials over which control is assumed, together with those available without a permit. The educational requirements and specialized training of workers, their medical examinations before and during work with radioactive materials are also spelled out in detail, outlining also the decontamination procedures to be followed. Establishment of the film dosimetric service eliminated on important shortcoming in the national radiation protection. The most backward area is in the handling of radioactive wastes. At present, only the handling of solid wastes is formally organized, but research is in progress on biological and liquid wastes and a pilot plant is scheduled to start operating soon. (TTT)

3407 EFFECT OF THE NONUNIFORMITY OF A BODY UPON THE DISTRIBUTION OF THE DOSAGE FIELD IN BEAM THERAPY. Krongauz, A. N.; Frolova, A. V.; Fadeeva, M. A. Med. Radiol., 11: No. 9, 3-7(Sept. 1966). (In Russian).

Radiation dosimetry for radiotherapy is usually calculated from data based on uniform media. However, the heterogeneity of the human body greatly affects dose distribution during irradiation. Correction for the nonuniformity of dose distribution in chest radiotherapy by statistical and rotational methods is evaluated, accounting for corrections for scattered radiation. (H.G.D.)

3408 THE DEFINITION OF DOSE EQUIVALENT, THE REM UNIT, AND THE VALUATION FACTORS. Berger, Hans; Harder, Dietrich; Huebner, Walter; Jaeger, Robert. Strahlentherapie, 131: 143-9(Sept. 1966). (In German).

The dose equivalent D_q is the product of the absorbed dose D and a valuation factor q, determined by mutual agreement and characterizing the risk from the different types of radiation in radiation protection work. The rem, originally proposed as roentgen equivalent man, serves for stating dose equivalents instead of the rad, but is identical to the absorbed dose unit rad. Until now these terms have not been closely defined. In the meantime, however, they have found general acceptance and it is necessary to have them approved as a standard. A specification to this effect will be issued by the German Committee on Radiological Standards in the near future. (auth)

3409 ORIGIN, DEVELOPMENT, AND COMPLETION OF HEMATOLOGICAL RADIATION PROTECTION. Chone, Bruno; Becker, Josef (Univ., Heidelberg). Strahlentherapie, 131: 51-68(Sept. 1966). (In German).

The problem of hematological radiation protection has undergone a change which results from more recent patho-physiological findings and improved diagnostic differentiation. For illustrating this development, a detailed historic review is given, followed by a discussion of morphological blood changes which are presently known to occur after radiation exposure. For classification and evaluation, special emphasis is put on functional tests which can be used as criteria for determining the extent of existing bone marrow reserve. A further diagnostic improvement can be obtained by using autoradiographic cytochemical procedures. Electromicroscopy is also important. The electronic registration of volume changes in leukocytes is, presently, the most sensitive method for detecting an effective radiation damage in the peripheral blood; it is based on the induction effect produced by the giant cells. This method allows an early morphological diagnosis, which cannot be obtained with the conventional counting procedures commonly used. These results open up new viewpoints for radiation protection, especially in regard to longitudinal sections and to an individual classification of radiation effect. Additional investigations are being done. (auth)

3410 NEUTRON DOSE DETERMINATION IN CASE OF CRITICAL ACCIDENTS BY GAMMA COUNTING OF THE FILLINGS IN PATIENTS' TEETH. Dierckx, R.; Horn, W. (EURATOM, Ispra, Italy). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-76/66, 20p. (CONF-660807-15). ORAU.

From Symposium on Neutron Monitoring for Radiological Protection, Vienna.

After the accident, mercury silver amalgam fillings are removed from teeth and counted by means of a calibrated gamma scintillator. Conclusions are as follows: The silver activity due to the reaction $^{109}Ag(n,\gamma)^{110m}Ag$ (half-life: 250 days) gives only indications for thermal neutron doses above 500 rad. The mercury activity due to the reaction $^{202}Hg(n,\gamma)^{203}Hg$ (half-life: 47 days) gives information for thermal neutron doses above 50 rad. The counting of the 511 keV annihilation peak from the reaction $^{63}Cu(n,\gamma)^{64}Cu$ (half-life: 12.9 h) can also be used to estimate the thermal neutron dose. Three hours after the accident a first estimation of the thermal neutron dose can be made by counting the 279 keV gamma-peak of the mercury-203 activity. After some days, accurate results can be obtained from this 279 gamma-peak counting. (H.J..W.)

3411 THE EXPERIMENTAL DETERMINATION OF THE NEUTRON RADIATION DOSE DISTRIBUTION IN THE HUMAN PHANTOM. Stipcic, Neda (Institut Ruder Boskovic, Zagreb). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-76/2, 12p. (CONF-660807-30). ORAU.

From Symposium on Neutron Monitoring for Radiological Protection, Vienna.

The quality of radiation delivered to the human phantom is quite different from that of the incident neutron beam. The present communication is concerned with the experimental investigation of the variation of neutron dose in relation to the variation of neutron fluence with depth into the human phantom. The distribution of neutron radiation was determined in the human phantom, a cube of dimensions $25 \times 25 \times 50$ cm, made of paraffin wax, the density of which was 0.92 g cm^{-3}. As neutron sources, Po–Be and Ra–Be point-sources were used. Neutron fluences were measured using different types of detector: scintillation detector, BF_3 counter, semi-conductor detector and nuclear track emulsions. Since the measurements of fluences with these four types of detectors were carried out under the same experimental conditions, it was possible to separate and analyze each part of radiation dose in paraffin. As the result of investigations, the distribution of the total radiation dose, as a function of the paraffin depth, was obtained. The maximum value of this dose distribution is constant with respect to the distance between the source and the paraffin phantom. (auth)

3412 METHODS OF ASSESSING ABSORBED NEUTRON AND GAMMA-RAY DOSE IN ACCIDENTS WITH A GRAPHITE

CRITICAL ASSEMBLY. Obaturov, G. M.; Zeinalov, E. I.; Kosenkov, A. V.; Shalin, V. A. Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-76/56, 22p. (In Russian). (CONF-660807-28). ORAU.

From Symposium on Neutron Monitoring for Radiological Protection, Vienna.

Methods of dose determination and personnel dosimetry for use in accidents experienced with a graphite critical assembly are discussed. This involved measuring neutron doses and gamma-ray doses in air, at the surface of and inside phantoms representing the human trunk and also the measurement of ^{24}Na radioactivity in a liquid phantom. Standard dosimetric equipment was used for the measurements including an IDN apparatus, an IFKNG personnel dosimeter and activation detectors such as indium, manganese, sodium, copper, phosphor and sulphur. The results of the measurements are given in tables and graphs. The experimental results show that to determine the exposure of a worker involved in an accident with a graphite critical assembly it is sufficient to determine the absorbed gamma-radiation dose averaged over the whole body, the absorbed gamma-radiation dose and the dose to the crystalline lens and gonads, due to charged particles formed by neutrons. Since the distribution of neutron fluxes in the vicinity of the critical assembly is uniform in the vertical direction, the absorbed dose to the crystalline lens and gonads can be determined using a personnel dosimeter, affixed to the chest, regardless of the position of the wearer relative to the direction of the incident flux. The average gamma-ray dose to the body can be assessed from the data provided by these personnel dosimeters and from measurements of sodium activity in the blood, using the formulas given. A table is presented that summarizes the methods of determining gamma-ray dose, and dose due to charged particles from neutrons at the surface, and the average dose over the entire body for a person exposed to an accident. (auth)

3413 RADIOACTIVITY SMEAR SAMPLING METHOD AND APPARATUS USING DATA PROCESSING CARDS. Hurst, J. S.; Pfeiler, W. A.; Sanders, M.; Gammon, E. F. (to U. S. Atomic Energy Commission). U. S. Patent 3,277,301. Oct. 4, 1966.

A method and apparatus for measuring radioactive deposits is provided using smear samples taken directly on precoded data processing cards. A mechanical card holder is utilized to hold a data processing card and force it against the surface being tested as the card and holder are passed along the surface. The cards containing smear samples are then processed through automatic equipment which measures the radioactivity of each smear sample and prints the results on a record medium. (AEC)

3414 SIMULATED RADIAC TRAINER. Jaquiss, Gerard J. (to U. S. Navy). U. S. Patent 3,276,143. Oct. 4, 1966. Filed July 22, 1964.

An invention is described which relates to radiation survey training, and more particularly to a method of training individuals in the survey of radiological hazards, and devices used in such training. This invention is an improved simulated radiometer. (B.G.D.)

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3415 (AED-C-10-05) BIBLIOGRAPHIEN ZUR KERNFORSCHUNG UND KERNTECHNIK. SEKTION 10: NUKLEARMEDIZIN. RADIONUKLIDE IN DER GASTROENTEROLOGIE. (Bibliographies in Nuclear Science and Technology. Section 10: Nuclear Medicine. Radionuclides in Gastroenterology). Oeff, K. (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Gmelin-Institut fuer Anorganische Chemie und Grenzgebiete, Frankfurt am Main (West Germany)). July 1966. 40p. Dep. mn.

This publication consists of a keyword index to a bibliography on radionuclides in gastroenterology. A separate index in which radioisotopes are the keywords is included. (H.L.W.)

3416 (UCRL-16806, pp 39-41) INVESTIGATIONS OF THE MECHANISM OF RADIOPROTECTION BY AMINOTHIOLS. Brown, Philip E. (California Univ., Berkeley. Lawrence Radiation Lab.).

Cystamine, one of the compounds most effective in protecting living material against ionizing radiation, has been shown to bind reversibly to DNA. The binding results in stabilization of the DNA helix, as indicated by the large increase in the melting temperature of the DNA. The dose of x or β rays at which destruction of the helix occurs is about 20 times as great for DNA bound with cystamine as for DNA alone. This protective effect is not due to scavenging by the excess cystamine in solution, but is associated with the bound cystamine. This in vitro protection may be due to removal of free radicals generated on the DNA, but it is suspected that a biological mechanism is more important for in vivo protection. (auth)

3417 INVESTIGATIONS ON BIOLOGICAL RADIATION PROTECTION. PART 72. THE EFFECTIVENESS OF VARIOUS RADIOPROTECTIVE SUBSTANCES IN FRACTIONATED X-IRRADIATION OF MICE. Langendorff, Hanns; Langendorff, Margarethe (Univ., Freiburg i. B. Heiligenberg-Institut, Baden, Ger.). Strahlentherapie, 131: 37-50(Sept. 1966). (In German).

The influence of 5-hydroxytryptamine (serotonin), homocysteine thiolactone · HCl (HCT), and of Chlorotrianisen (Tace) on mice which had received a fractionated x irradiation with 100 R daily is reported. The results obtained show that the protective substances investigated are less effective in the case of fractionated irradiation than in the case of a single irradiation with a higher dose rate. Compared with untreated control animals, a repeated administration of HCT causes an increase in radiation sensitivity in mice which had received fractionated irradiation. Due to the long lasting effect of Tace, a protective effect is obtained even with a single administration; with higher total radiation doses a sensitization is observed. The effect of Tace is believed to be due to a toxic factor, which increases with increasing radiation dose. (auth)

3418 COMPLETE REGRESSION, FOLLOWING ABDOMINAL IRRADIATION ALONE, OF CHYLOTHORAX COMPLICATING LYMPHOSARCOMA WITH ASCITES. Swensson, Norman L.; Kurohara, Samuel S.; George III, Frederick W. (Naval Hospital, San Diego, Calif.). Radiology, 87: 635-40(Oct. 1966).

Two cases of chylothorax complicating lymphosarcoma with ascites are presented to call attention to the remarkable complete regression of the chylothorax following cobalt teletherapy delivered to the abdomen only. Retroperitoneal lymphatic involvement, confirmed by surgery in one case and by lymphangiography in the other apparently was the cause of the ascites and chylothorax. The commensurate regression of chylothorax with the ascites supports the ample evidence provided previously in that ascites can form pleural effusions directly across the barrier of the diaphragm, either through a diaphragmatic defect or possibly through diaphragmatic lymphatics or both. Because of this it would appear that the management of chylothorax in similar cases should be directed toward eliminating and preventing recurrence of ascites, preferably by whole-abdomen irradiation. (auth)

3419 HEMATOPOIESIS IN IRRADIATED ANIMALS DURING TREATMENT WITH DIPHACYL. Traskunova, N. V. Med. Radiol., 11: No. 9, 53-8(Sept. 1966). (In Russian).

The radioprotective effects of the diphenylacetic ether of diethylaminoethanol (diphacyl) was studied in rabbits given 600 R x-ray doses. Radiation effects on megakaryocytopoiesis were inhibited and thrombocytopenia was markedly reduced in most animals during the course of radiation sickness. Bone marrow from rabbits treated with diphacyl was richer in cellular elements of the granulocytic series in comparison with controls. Survival was not enhanced by diphacyl. (H.G.D.)

3420 CHANGES IN THE MYELOGRAM OF NORMAL AND IRRADIATED RATS AFTER ADMINISTRATION OF SEROTONIN. Pukhal'skaya, E. Ch.; Golubkova, S. N.; Nivinskaya, M. M.; Lyufachun, A. S. Med. Radiol., 11: No. 9, 60-5(Sept. 1966). (In Russian).

A repeated subcutaneous administration of serotonin in doses of 5 to 10 mg/kg caused a distinct rise of the percentage of cells in the reticular syncytium of rat bone marrow. A similar reaction of the bone marrow was observed in rats after serotonin administration in the stomach by means of a tube. Indices of maturation of granulocytes and erythroblasts in the bone marrow did not change. Serotonin caused a moderate leukocytosis in peripheral blood at the expense of augmented quantity of mature neutrophils and lymphocytes. Maturation of granulocytes in the bone marrow and their increased quantity in the blood was enhanced by repeated subcutaneous injections of serotonin in rats exposed to 650 R whole-body irradiation. (H.G.D.)

3421 CLINICO-ROENTGENOLOGICAL STUDIES OF AFFECTION OF THE PULMONARY TISSUE WITH COLLOIDAL ^{198}Au. Seryi, S. V.; Kiseleva, E. S.; Dostanova, T. K. Med. Radiol., 11: No. 9, 65-9(Sept. 1966). (In Russian).

Clinical and radiological diagnoses of injuries to the pulmonary tissue when colloidal ^{198}Au entered the bronchus as a complication during intrapleural administration for cancer of the lung are compared. Features peculiar to the course of the radiation reaction to colloidal ^{198}Au and to external exposures are discussed. (H.G.D.)

3422 RELATION BETWEEN RADIATION AFFECTIONS OF THE SKIN AND THE CYCLE OF HAIR GROWTH. Turusov, V. S. Med. Radiol., 11: No. 9, 70-3(Sept. 1966). (In Russian).

Cyclic changes associated with the hair cycles of the skin exert an essential influence on the diverse effects of radiation action on the skin. Epilation occurs significantly more rapidly during irradiation at the period of hair growth. Only after irradiation at the period of hair growth is there seen a dark pigmentation of the skin associated with the elimination of the pigment from the destroyed bulbs. Graying hair is markedly more apparent in the persons irradiated during the period of rest. The normally existing cyclic alteration of the pigmentation of the skin disappears after irradiation; the skin irradiated during the period of growth becomes dark, whereas that irradiated at rest acquires a constant mild pink pigmentation. (auth)

3423 GENERAL NONSPECIFIC IMMUNOLOGICAL REACTIVITY IN PERSONS WORKING IN CONDITIONS OF CHRONIC ACTION OF IONIZING RADIATION. Gribova, I. A. Med. Radiol., 11: No. 9, 74-8(Sept. 1966). (In Russian).

Immunological reactivity was studied by an intradermal test with antihuman serum. It was noted that the prolonged action of ionizing radiation in doses 4 to 5 times exceeding permissible ones could lead to changes in the general immunological reactivity. These changes are manifested by the appearance of a certain percentage of persons with reduced indices of the test. In persons working in conditions of ionizing radiation in doses not exceeding the maximally permissible levels, no essential changes were observed in the general immunological reactivity. There was seen only an insignificant reduction of the incidence of cases with high test indices at the expense of an increased number of persons with mean reactivity level. (auth)

3424 HYSTEROGRAPHY IN INTRACAVITARY TREATMENT OF CANCER OF THE UTERINE BODY WITH ^{60}Co BEADS. Shnirel'man, A. I.; Kiseleva, V. H. Med. Radiol., 11: No. 9, 7-11(Sept. 1966). (In Russian).

Hysterographic findings in patients with uterine carcinomas are presented, and the importance of hysterography prior to intracavitary introduction of ^{60}Co beads is emphasized. The value of hysterography in deriving an effective program for treatment is discussed and illustrated with data on 45 patients in which the technique was applied prior to therapy for uterine carcinoma. (H.G.D.)

3425 RADIOISOTOPE DIAGNOSIS OF CANCER WITH THE AID OF COMET-A RADIOMETER. Khripta, F. P. Med. Radiol., 11: No. 9, 11-16(Sept. 1966). (In Russian).

Minimal quantities of ^{32}P permitted diagnosis of diversified tumors (esophagus, stomach, uterus, etc.) with a radiometer composed of a large number of beta counters. In 350 patients with tumors variously located, ^{32}P accumulations varied significantly in benign and malignant tumors. Radiodiagnosis was confirmed clinically in 81.1 to 97.1 per cent of the cases. (H.G.D.)

3426 USE OF DRY LEUKOCYTIC MASS IN THE SYSTEM OF TREATMENT OF LEUKOPENIA OF RADIATION ORIGIN. Bogoyavlenskaya, M. P.; Vinograd-Finkel, F. R.; Fedorova, L. I. Med. Radiol., 11: No. 9, 45-53(Sept. 1966). (In Russian).

The therapeutic effectiveness of intramuscular injections of suspensions of dry leukocytic mass in the treatment of radioinduced leukopenia resulting from radium therapy of malignant neoplasms is discussed. The preparation, which could be preserved up to 2 yrs, resulted in a high rate of recovery among leukopenic patients. (H.G.D.)

3427 THE STATE OF DNA AND PROTEIN SYNTHESIS IN RADIOPROTECTED RATS AFTER LETHAL IRRADIATION. Dimitrov, L. (Higher Inst. of Medicine, Sofia). Compt. Rend. Acad. Bulg. Sci., 19: 433-6(1966). (In Bulgarian).

The protective effects of a mixture of radioprotectors (serotonin, AET, MEA) in combination with therapeutic agents (bone marrow, antibiotics, and vitamins) were determined on the separate elements of DNA and protein synthesis in rats. The state of the DNA synthesis was evaluated from the incorporation of ^{32}P-$Na_2HP^{32}O_4$ and thymidine-2-^{14}C, and by the activity of the DNA-ase II. An analysis of the results shows that: a whole-body single lethal irradiation of albino rats inhibits the individual elements of the synthesis of DNA and protein; radioprotectors (serotonin, AET, and MEA) and in combination with therapeutic agents (bone marrow, antibiotics, and vitamins) protect the animals from disturbances in the DNA and protein metabolism in the early and later periods following lethal irradiation; and the average life expectancy of irradiated radioprotected rats is shorter than that of nonirradiated animals. (TSS)

3428 MOVING-FILTER APPLIED TO ARC THERAPY. STUDIES ON CONFORMATION RADIOTHERAPY, 15 REPORT. STUDIES ON TELECOBALT THERAPY, 26 REPORT. Morita, Kozo (Univ. of Nagoya, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 26: 66-77(Apr. 1966). (In Japanese).

In arc therapy, the position, shape and size of the region contoured by 90% isodose curve (beam focus) are usually shifted and deformed from those of the expected beam focus area. In order to coincide the beam focus with the expected beam focus area, the moving-filter is devised. The arc-shaped filter is attached to the front of the radiation mouth. The filter rotates counter-clockwise synchronously with clockwise rotation of the radiation source around the patient, so that the filter keeps the definite direction in spite of rotation of the radiation source. A suitable thickness of moving-filter can be calculated by these equations and figures and the results obtained theoretically nearly coincide with experimental results. Using moving-filter with suitable thickness for arc therapy of 180°, it is shown that the position, shape and size of the 90% dose region and those of the expected beam focus area correspond well. (auth)

3429 HEAVY PARTICLES IN EXPERIMENTAL MEDICINE AND THERAPY. Lawrence, John H.; Tobias, Cornelius A.; Born, James L.; Linfoot, John A.; D'Angio, Giulio J. (Univ. of California, Berkeley). J. Amer. Med. Ass., 196: 166-70(Apr. 11, 1966).

Experimental and clinical studies using heavy particles are described after a consideration of some of the differences and advantages of radiotherapy with these particles as compared with electromagnetic radiations. Studies on the proliferative capacity of mouse ascitic tumor cells in vivo demonstrated the advantageous properties of the high-LET heavy particles. Studies on the skin of rabbit ears of the acute reactions from varying LET radiations have also demonstrated the greater RBE of the higher LET radiations. Heavy-particle beams for medical use require energies in excess of 100 MeV, and there are seven institutions in the United States, and seven others throughout the world, which have cyclotrons with energies high enough to be useful in therapy. Use of heavy particles to treat acromegaly, diabetic retinopathy, and Cushing's disease is outlined. Work is being directed toward obtaining pion and muon sources for therapeutic use. (TCO)

3430 INVESTIGATIONS ON BIOLOGICAL RADIATION PROTECTION. PART 73. THE EFFECTS OF PYREXAL (LIPOPOLYSACCHARIDE FROM SALM. ABORTUS EQUI) ON SURVIVAL RATE AFTER X-IRRADIATION. Flemming, Kurt; Flemming, Christa (Heiligenberg-Instituts, Baden, Ger. Univ., Freiburg i. B.). Strahlentherapie, 131: 150-9(Sept. 1966). (In German).

Pyrexal (lipopolysaccharide from Salm. abortus equi) shows protective as well as a therapeutic effect in x-irradiated rats, mice and guinea pigs. In mice, pyrexal is effective in a broad dose range from 0.001 to 100 μg/animal (0.05 to 500 μg/kg body weight). A maximum effect was obtained with 500 μg/kg body weight and sublethal radiation doses. The pyrexal effect depended greatly on the time of injection: an injection done 96 hours prior to irradiation resulted in an increased radiation sensitivity. The time dependency of the pyrexal protection in rats and guinea pigs was different from that in mice. (auth)

3431 CHEMICAL PROTECTION FROM IONIZING RADIATION. V. COMPARATIVE HISTOPATHOLOGIC OBSERVATIONS ON SOME ORGANS OF MICE IRRADIATED AFTER PRIOR PROTECTION WITH SODIUM CYSTEINETHIOSULFONATE (CTS) AND WITHOUT PROTECTION. Zebro, Tadeusz (Medical Academy, Krakow). Acta Med. Pol., 7: 83-95(1966).

To ascertain whether CTS administered in nontoxic doses protects the internal organs from postradiation damage, the gastrointestinal tract and kidneys of irradiated and unirradiated mice were studied histologically. Whole-body x irradiation of mice with a dose of 500 R caused marked damage to the internal mucosa and kidneys, seen mainly as degeneration and necrosis of the epithelia. The lesions in the mucous membrane of the small intestine had a biphasic course; the most severe changes appeared on the 3rd to 5th and about the 15th day after irradiation. The most severe damage to the kidneys appeared between the 3rd and 8th day. These changes may explain the mechanism of later complications in the course of radiation sickness such as bacteremia and late focal fibrosis in the kidneys. CTS administered intraperitoneally exerted a protective action as manifested by less extensive postradiation lesions in the intestinal mucosa and epithelia of the renal tubules, and by quicker repair of the damage brought about in these organs by irradiation. (TSS)

3432 IRRADIATION PLAN IN MEGAVOLT THERAPY. Tholen, J. M. G. Jaarb. Kankeronderz. Kankerbestrijding Ned., 14: 141-51(1964). (In Dutch).

Fundamental concepts of tumor irradiation are explained for planning dose levels and treatment schemes in ^{60}Co teletherapy. Only by careful planning in individual cases can healthy tissues be spared injury while delivering a tumoricidal dose to the cancer. Isodose charts are provided for various fields, with and

without wedge modification of the beam. Design and construction of a new apparatus are described which aid in determining contours for use in pendulum therapy. The technique used with this apparatus avoids hot spots in the treatment field, and consequent tissue injury, allowing more homogeneous distribution of the dose over the tumor zone. Compensating filters for use in treatment of head and neck tumors are also illustrated. (BBB)

3433 APPARATUS AND AIDS IN RADIOTHERAPY. Scholte, P. J. L. Jaarb. Kankeronderz. Kanderbestrijding Ned., 14: 129-39(1964). (In Dutch).

Physical bases of radiotherapy are discussed, with reference to the specific effects of orthovoltage x rays, ^{60}Co γ radiation, 18- and 31-MeV electrons, and radioisotope contact therapy. Tissue effects and prevention of complications with each mode of therapy are examined. The main problem is to irradiate a well-defined volume of tissue, larger than the volume occupied by the malignant tissue, referred to as the target, while keeping exposure of the surrounding tissue as low as possible. To achieve this with the aid of radiation passing through the skin, the type and the quality of the radiation must be chosen carefully. It is shown that the conventional radiation of low energy (orthovoltage) can only be used in exceptional cases. In all cases in which the target is located at a great depth, high energy radiation (megavoltage) is preferable because of the useful build-up effect (reduced skin reaction), more favorable depth dose curves at greater depth, and absence of differential bone absorption. To irradiate targets at an intermediate depth or at the surface of the body the use of β rays is recommended as the depth dose curves of this radiation are most favorable. It is emphasized that a simple apparatus that is easy to handle has great practical advantages because greater accuracy can be attained when irradiating the target. Sealed and open radioactive sources are dangerous for personnel, difficult to handle, and the treatment is time-consuming because of the complicated calculations to determine the dose. The treatment of the uterus with sealed radium sources constitutes the only favorable exception. The results obtained with open sources are disappointing. (BBB)

Radiation Effects on Animals

3434 (JUL-356-ME) EINE EINRICHTUNG ZUR OERTLICHEN BESTRAHLUNG VON TRANSPLANTIERTEN MAEUSETUMOREN MIT THERMISCHEN NEUTRONEN AM REAKTOR FRJ-1. (An Arrangement for the Local Irradiation of Transplanted Mouse Tumors with Thermal Neutrons from the FRJ-1 Reactor). Porschen, W. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Medizin). Feb. 1966. 37p. Dep. mn.

The irradiation device BE-15 was constructed in the thermal column 1 of the FRJ-1 Reactor. The irradiation device was used principally for the irradiation of tumor-bearing mice; the first irradiation of this type was carried out on Sept. 23, 1965. The thermal neutron flux on the ^{10}B-labeled tumors was about 2.2×10^9 neutrons/cm^{2}sec; the neutron flux on the body was reduced by a factor of 10 to 20 by a lithium fluoride-paraffin shield. The cadmium proportion (Au foils) had the value 32.3 and the fast neutron flux (E 1 MeV) was 3.1×10^8 neutrons/cm^{2}sec. The irradiation time was between 13 and 30 min; the neutron flux on the tumor attained values of 1.7×10^{12} neutrons/cm^2. In addition to the irradiation of mice, irradiations of other biological objects could also be carried out. Only slight modifications are necessary for these irradiations, and they can be accomplished in a few minutes. A neutron flux density of 3×10^9 neutrons/cm^{2}sec in a volume of $16 \times 16 \times 4$ cm^3 is available. The dose output of the thermal neutrons is 10^4 rem/hr. The dose output of the simultaneously present hard gamma radiation has a value of about 300 r/hr. The whole-body burden of the research animals with gamma radiation (nuclear gamma radiation and capture gamma radiation) is less than 100 to 130 r. (tr-auth)

3435 (UCSF-34P41-13) THE EFFECT OF THYMECTOMY AND SPLENECTOMY ON THE COURSE OF X-RAY INDUCED PROGRESSIVE INTERCAPILLARY GLOMERULOSCLEROSIS IN THE MOUSE KIDNEY. Guttman, Paul H. (California Univ., San Francisco. Medical Center). June 1, 1966. Contract AT(11-1)-34. 21p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Whole body neonatal irradiation (450 rads) of Swiss-Webster mice resulted in progressive intercapillary glomerulosclerosis (IGS). Neonatal thymectomy potentiated the effect of irradiation. Removal of the spleen at 18 days markedly reduced the effect of irradiation on the kidney when combined with thymectomy at birth. In the presence of an intact thymus, splenectomy had no effect on the course of radiation induced IGS. Germinal center formation and plasma cell infiltration were observed in the thymus of splenectomized-irradiated mice. The possible role of immunity in the pathogenesis of late effects of x ray on the kidney is considered in the light of these findings. (auth)

3436 INTESTINAL DAMAGE AND WATER IMBALANCE IN GAMMA-IRRADIATED LARVAE OF BOMBYX MORI. Lassota, Z. Bull. Acad. Pol. Sci., Ser. Sci. Biol., 14: 293-6(1966).

Bombyx larvae of warska race, feeding on mulberry leaves were irradiated 2 to 3 days after the 4th molting with a single dose of 20, 65, or 200 kR of ^{60}Co γ rays, and were compared with a simultaneously grown, non-treated group of animals of the same age. In each group 60 animals were investigated in two consecutive series of experiments. In control groups feeding lasted for 6 to 7 days after irradiation and then after one day of fasting the spinning set on. The average body weight increased during the feeding period. In groups irradiated with 20 kR the apparently normal feeding lasted by one day longer than in controls but the maximum average body weight attained, was lower and half of the animals died during the silk-spinning period. In the groups irradiated with 65 kR the feeding period lasted by three days longer than in controls, the average weight of the larvae was similar to that of the 20 kR-treated animals but more than half of the larvae died at the end of the feeding period and the remaining ones with the exception of a few, just when they began to spin. In the groups irradiated with 200 kR three from sixty individuals died during irradiation. The survivors were strikingly sluggish, their bodies were flabby, only few of them fed and their body weight decreased below the initial level. No larvae in these groups survived more than 4 days after irradiation. One to two and five to six days after irradiation, the reducing substances in the blood were determined by cold and hot as well as by the anthrone method. (H.G.D.)

3437 X-RAY DETECTION BY THE OLFACTORY SYSTEM: OZONE AS A MASKING ODORANT. Gasteiger, Edgar L.; Helling, Sharon A. (Cornell Univ., Ithaca, N. Y.). Science, 154: 1038-41(Nov. 25, 1966).

The technique of masking was used to test the hypothesis that x-ray detection is mediated by an odorant produced in irradiated air. Rats conditioned to cease licking during exposure to x rays (conditioned suppression) did not display this conditioned response in the presence of ozone and strong volatile oxidants. (auth)

3438 CONGENITAL ANOMALIES AMONG CHILDREN BORN OF IRRADIATED WOMEN. Tabuchi, Akira (Hiroshima Univ. School of Medicine). Nippon Sanka Fujinka Gakkai Zasshi, 9: 210-21(July 1962).

Incidence of defective children of mothers exposed before or during pregnancy to radiation from atomic bombing or medical radiologic procedures is reported. A survey conducted in Hiroshima from 1 January 1950 to 3 June 1959 revealed that the number of still births (66.62) and artificial interruptions of pregnancy (55.20 per 1000) was larger than the national average. The number of still births in irradiated women (69.00) and artificial interruptions of pregnancy (57.18) was larger than that in unirradiated women (66.24 and 54.93) and the spontaneous still birth rate was highest in those exposed at short distances from the hypocenter. However, another survey on children born at 7 hospitals in Hiroshima Prefecture from January 1961 to 1962 revealed no increase in congenital anomalies, even in children born of parents both of whom were exposed to the atomic bomb. Biometry of 61 children whose mothers became pregnant after atomic bomb exposure showed no significant difference from controls but 6 of them showed maldevelopment. A survey of the body weight at birth of children (1480) born of irradiated women from 1 January 1951 to 31 August 1955 revealed that the body weight at birth of boys was 3024 g and that of girls was 2999 g, while that of control boys was 3054.35 g and that of control girls was 3007.05 g, indicating a slight decrease in the irradiated group as compared with the control group. A survey of children born of 45 mothers irradiated for medical reasons during pregnancy revealed no difference in the incidence of still birth, immature children, and perinatal death before irradiation as compared with after irradiation but one case of deformity was noted (a 26-yr-old mother had received abdominal roentgenography in the 5th month of pregnancy and gave birth to a girl with congenital hip joint dislocation). At present, the only clinical findings attributable to the effects of radiation on children born of irradiated women are microcephalia and mental retardation. (BBB)

3439 RADIATION EFFECTS ON FRIEND VIRUS DISEASE. PART I. Adachi, Tadashi; Sakamoto, Kiyohiko (Tokyo Medical and Dental Univ.). Bull. Tokyo Med. Dent. Univ., 12: 97-108(Mar. 1965).

Effect of x irradiation of mice injected with Friend virus was studied. This disease is characterized by enlarged spleen and appearance of abnormal cells in the peripheral bloodstream. It was established by injecting Friend virus intraperitoneally in mice of the dd strain. In controls, 80% of mice with Friend virus disease

died within 100 days. To study the irradiation effects on the process of this disease, whole-body x irradiation was employed, and enlargement of spleen, mortality, and histological findings were observed. Single and fractionated irradiations were used. Single irradiation doses of 500, 300, and 200 R, fractionated irradiation of 500 R total dose in 5 and 10 days, and 300 R total dose in 3 and 6 days were given. The influence on mortality was almost negligible except in the single 200 R dose group. The suppressive effects on splenomegaly, however, were marked in all irradiated mice, especially with the single 500 R irradiation. The spleen of mice with Friend virus disease showed a marked increase of atypical cells in red pulp and normal structure was no longer seen. This change was most prominent on the 7th day after inoculation of virus. Irradiated specimens showed suppression of these changes in accordance with dose. (BBB)

3440 LAPAROSCOPIC PICTURE OF THE THOROTRAST LIVER. Frenger, W.; Heinkel, K. (Univ., Erlangen, Ger.). Med. Bild-Dienst, 2: 18-21(June 1962). (In German).

Laparotomy studies were performed in two patients with demonstrated liver deposition of ThO_2. In one patient the liver was a reddish-grey color with a grayish-white network throughout the entire tissue. Its entire surface was covered with nodules. There was no evidence of metastatic areas. Histological study of tissue from the left lobe showed high grade cirrhotic structure with extracellular and intracellular incorporation of foreign bodies. In the second patient the liver was small and colored a dark brownish red. A dense, fine, white network of tissue was sharply differentiated from the parenchyma. There was considerable nodularity, without presenting a typical picture of cirrhosis. The tissue was rather friable. Histologically, lumpy, granular material was present in the reticular cells. (TCO)

3441 IN-VITRO INVESTIGATIONS OF THE ABSORPTION CAPACITY OF THE SMALL INTESTINE AFTER SUPER-LETHAL X-IRRADIATION. Zseboek, Zoltan B.; Janossy, Gyoergy; Petranyi, Gyoezoe Jr.; Kovacs, Laszlo (Medizinische-Radiologische Forschungsinstitut, Budapest). Strahlentherapie, 131: 122-36 (Sept. 1966). (In German).

Functional disturbances in the absorption of water, sodium, chloride, and glucose occurring in the small intestine of rats were investigated in vitro 24, 48, and 72 hours after whole body x irradiation with 1,500 R. The absorption of all substances was increased 24 hours after irradiation; the absorption was decreased 48 hours and considerably decreased 72 hours after irradiation and reached the low level of the irradiated intestine which was perfused without glucose. The ion concentration of the absorbed liquid was proportional to the extent of the damage to the epithelium and the decrease in water transport, and approaches the concentration values of the perfusion solution (Krebs-Ringer-solution). Histological and histochemical studies showed that there was no significant functional difference between the intestine which had been perfused in vitro for 1 hour and the intestinal regions which had been fixed before the perfusion. Therefore, this method can be considered to be suitable for investigating this problem. (auth)

3442 RADIOBIOLOGICAL INVESTIGATIONS WITH CHROMIUM-LABELED ERYTHROCYTES. IV. IS THERE A RELATION BETWEEN ERYTHROCYTE LIFETIME AND RADIOSENSITIVITY? Kuenkel, Hans A.; Mauss, Hans-Joerg; Mihm, Knut (Univ., Hamburg). Strahlentherapie, 131: 137-42(Sept. 1966). (In German).

Red cell survival was determined by the use of chromium-51 in two different strains of rats (Wistar and BD1). The mean survival time was 52 days in Wistar-rats and 68 days in BD1-rats. After whole-body x irradiation with 900 R 77% of the Wistar-rats died within 30 days. BD1-rats, however, were extremely radioresistant (mortality after 900 R: 21% in 30 days). Red cell survival is not shortened by radiation of this dosage range. In two different strains of mice similar differences were observed. The life span of the erythrocytes of C57-mice was found to be 34 days, that of NMRI-mice 46 days. After irradiation with 550 R 78% of the C57-mice died within 30 days, whereas a mortality of only 34% was observed in NMRI-mice. In this case, too, animals with shorter red cell survival were much more radiosensitive. It is supposed that there exists a general connection between radiosensitivity of mammals and survival time of their erythrocytes. The increased radiosensitivity of animals with erythrocytes of shorter life span (compared with another strain of the same species) might be caused by a faster turnover and rapid production of new red cells in the bone marrow of those animals. (auth)

3443 OSSEOUS TUMORS INDUCED BY X-RAY TREATMENT OF EXTREMITIES IN RATS. Studitskii, A. N. (Severtsov Inst. of Animal Morphology, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 167: 1411-13(Apr. 21, 1966). (In Russian).

Data are presented on the osseous tumors induced by x-ray treatment of extremities in rats. An attempt is made to explain this phenomenon on the basis of inhibited regulation etiology. Histological investigation confirmed the postulation which stated that radiation trauma inhibits the growth and form-forming processes in tubular bone. This in turn is followed by discontinued or distorted tissue reactions necessary for the stable tissue protein synthesis. (R.V.J.)

3444 ADENOMA IN RAT PITUITARY GLANDS AFTER X-IRRADIATION OF THYROID GLAND. Griesbach, W. E.; Nichols, C. W. Jr.; Chaikoff, I. L. (Medical Research Council, Dunedin, New Zeal. Univ. of California, Berkeley). Arch. Pathol., 82: 356-62(Oct. 1966).

The pituitaries of 323 female rats were studied (166 served as controls and in 157, 1,000 R of x-irradiation were applied to a single lobe of the thyroid gland, the alternate lobe being shielded under 1 mm of lead foil). Seventy-seven of the control and 78 of the irradiated rats were fed a diet containing desiccated thyroid powder. The rats were sacrificed two years after the irradiation. One hundred and seventy-seven (55%) of the pituitaries contained one or more adenomas. Of these neoplastic pituitaries, 50 (28%) were thyrotropic (TSH) adenomas, 16 of which were found in the controls and 34 in the irradiated rats. (auth)

3445 STUDY OF REGENERATION IN ASTERINA GIBBOSA PENN. (ECHINODERME ASTERIDE) AFTER IRRADIATION WITH X RAYS. Huet, Michel (Faculte des Sciences, Orsay, France). Compt. Rend. Soc. Biol., 160: 466-9(1966). (In French).

Results are reported from a histological study of regeneration in x irradiated starfish after whole- or partial-body exposure. Regeneration was evaluated on the basis of the appearance of eye color and differentiation in dermal cells in the anterior appendage at various times up to 58 days post-irradiation, at which time regeneration was complete. (C.H.)

3446 INFLUENCE OF ELECTROMAGNETIC RADIATION EMITTED BY RADAR ON THE PHAGOCYTIC FUNCTION OF CELLS IN THE RETICULO-ENDOTHELIAL SYSTEM OF MICE. Plurien, G.; Sentenac-Roumanou, H.; Joly, R.; Drouet, J. (Centre d'Etudes et de Recherches de Biologie Appliquees a la Marine, Toulon, France). Compt. Rend. Soc. Biol., 160: 597-9(1966). (In French).

The effects of high frequency electromagnetic radiation emitted by radar on phagocytic activity of cells of the reticulo-endothelial system of mice were studied. Results indicated a period of excitation was followed by a depression of phagocytic activity during chronic exposure over a 20 day period. (C.H.)

3447 EFFECT OF ^{14}C ON EMBRYONIC AND EARLY POST-EMBRYONIC DEVELOPMENT OF COREGONUS PELED. Fedorova, G. V (Zhdanov State Univ., Leningrad). Nauch. Dokl. Vyssh. Shkoly, Biol. Nauk., No. 2, 84-7(1965). (In Russian).

Carbon-14-labeled sodium acetate and sodium bicarbonate were used in studies on embryonic and early postembryonic development of Coregonus peled. With both of these compounds, the highest mortality of spawn occurred when the activity of the water was 2×10^{-4} Ci/l. The postembryonic stage of the fish was much less sensitive to carbon-14. (H.L.W.)

3448 EFFECTS OF IRRADIATION WITH ^{60}Co ON THE AMINO ACID CONTENT OF THE LIVER AND KIDNEY OF THE RAT. Erede, Paulo; Durst, Franca; Podesta, Anna Maria (Univ., Genoa). Pathologica, 56: 245-8(Sept.-Oct. 1964). (In Italian).

Rats 2½ months old were exposed to various doses of ^{60}Co γ radiation: 300 R in three 100-R doses, 450 R in two 225-R doses, 450 R in a single dose, and 600 R in a single dose. Eight days after the last radiation exposure, liver and kidney were removed and hydrolyzed in 6N HCl. Amino acids in these organs were then studied by two-dimensional chromatography. The liver of irradiated rats showed lower levels of glycine and threonine than normal liver. The nitrogen content of liver also decreased as a result of irradiation, from a control level of 27.8 mg N/g to 25.9 in the 600-R group. In irradiated kidney, lower than normal contents of glutamic acid, glycine, threonine, leucine, and basic amino acids (lysine, arginine, and histidine) were noted. In kidney also, N content decreased, from 28.9 mg N/g in controls to 25.8 in the 600-R group. Levels of cystine, serine, alanine, tyrosine, valine, and phenylalanine were relatively unaffected in both organs by irradiation. In general, the decline in the other amino acids and in N content was proportional to the radiation dose. (BBB)

3449 RADIOAKTIVITAET UND VETERINAERMEDIZIN. (Radioactivity and Veterinary Medicine). Wegener, K. H. Berlin and Hamburg, Verlag Paul Parey, 1966. 228p.

On the basis of a literature survey, the basic information on radioactivity and radiation of interest to the veterinarian is com-

piled. The sources and types of natural and artificial radiation are outlined. The radioinduced damage that can occur in animals is described. The use and elimination of radio-injured animals are discussed. The risks involved for the user of contaminated food are considered. Methods and techniques used for environmental monitoring are outlined. The effect of ionizing radiation on food of animal origin, protection of food, and radiopreservation of foods of animal origin are discussed. The use of radioisotopes in veterinary research and practice is reviewed. The principal provisions of atomic and radiation laws are reviewed. 254 references. (J.S.R.)

Radiation Effects on Plants

3450 INFLUENCE OF LARGE DOSES OF ^{60}Co γ-RAYS ON SOWING QUALITY OF SEEDS, AND GROWTH AND YIELD OF SUGAR BEETS. Keleberda, G. G. Visn. Sil'skogospodar. Nauki, 8: 75-7(1965). (In Ukrainian).

Seeds of sugar beets were irradiated with ^{60}Co gamma rays (500 to 800,000 R) a few days prior to sowing. Doses up to 1000 R had no effect. Sprouting increased 9 to 10%, first leaves were smaller, chlorophyll and carotene syntheses were reduced, and beet weight and sugar content were lower in plants from seeds given 10,000 and 25,000 R, as compared to nonirradiated controls. In plants from seeds exposed to 50,000 R, germination was delayed 2 to 3 days; morphological lesions were induced in the 1st pair of leaves; fewer leaves were formed; biological maturity was accelerated; and root weights and sugar contents were decreased by 30%. Root decay after 75,000 and 100,000 R doses resulted in plant death 42 days after sowing. Germination was reduced 5 to 9% by 50,000 to 100,000 R, and the lethal dose was 800,000 R. (H.G.D.)

3451 COMPARATIVE INVESTIGATION OF RADIORESISTANCE OF WHEAT VARIETIES IN EARLY STAGES OF GERMINATION. Reuther, G. (Kernforschungsanlage, Juelich, Ger.). Radiat. Bot., 6: 433-43(Oct. 1966). (In German).

The x-ray resistance of winter wheat varieties Bayro, Peragis and Walthari during germination up to 24 hr was investigated. The specific resistance of the varieties is very high after irradiation of dormant seeds. The following sequence of decreasing resistance has been observed: Bayro > Peragis > Walthari. The relation of resistance changes with different periods of soaking at DL_{50} in the following way: 8–10 hr Peragis > Bayro > Walthari; 24 hr Walthari > Peragis > Bayro. The change in the relation of resistance between the varieties not only depends on the differential effect of equal water content after soaking, but more on the activation of storage products at different times. The beginning of the premitotic radiosensitive phase coincides with the increase in physiological activity; its course was determined on the basis of the release of amino acids and monosaccharides. The physiological sensitive phase, expressed by the reduction of the DL_{50} per 1 per cent water uptake, starts after a germination period of 5 hr in the variety Walthari, after 8 hr in Bayro and after 10 hr in Peragis. The factors modifying x-ray resistance in the early stage of germination and the radiosensitive stage before the beginning of the cell division are discussed. (auth)

3452 STUDIES ON RADIATION-INDUCED ETHYLENE PRODUCTION BY LEMON FRUITS. Maxie, E. C.; Rae, H. L.; Eaks, I. L.; Sommer, N. F. (Univ. of California, Davis). Contracts UCD-34P80; UCD-34P73. Radiat. Bot., 6: 445-55(Oct. 1966).

Two systems are operative in producing ethylene (C_2H_4) in γ-irradiated lemon fruit. One is a non-enzymatic radiolysis of fruit constituents which may be mediated by oxygen or free radicals produced by the radiolysis of water. The second system is metabolic and oxygen-dependent. It apparently begins during irradiation and reaches its maximum rate several days later. Direct radiolytic production of C_2H_4 from acids of the TCA cycle, linolenic acid and lemon oil, was shown. Irradiation of linolenic acid with sunlight also produced C_2H_4. Both γ- and sunlight-irradiation of linolenic acid and lemon oil involves formation of peroxides and probably free radicals. Values measured for C_2H_4 production by lemon fruits during γ-irradiation are probably low because of destruction by ozone, radiolysis or polymerization. (auth)

3453 RESEARCH USES OF THE GAMMA FIELD AND RELATED RADIATION FACILITIES AT BROOKHAVEN NATIONAL LABORATORY. Sparrow, Arnold H. (Brookhaven National Lab., Upton, N. Y.). Radiat. Bot., 6: 377-405(Oct. 1966). (BNL–10225).

The gamma sources used at Brookhaven for genetical, botanical and ecological studies are listed and described briefly. They include a 60 C ^{60}Co hot cell source, a 9 C ^{60}Co greenhouse source, a 3160 C ^{60}Co field source, a 9500 C ^{137}Cs forest source and a 400 C ^{137}Cs pit source. (Sources completed since this material was presented are described in an addendum.) The pit source is set up to simulate fallout decay, i.e., exposure rates can be decreased as desired by means of programmed changes in shielding. Described or listed are some of the more important recent experiments, observations and conclusions covering many areas of investigation in which use has been made of the various radiation facilities listed above. These include studies in radiation cytology and genetics elucidating certain aspects of the dose-rate effects problem; studies on somatic mutations in many species (a list of useful mutations is also given); studies of morphological and histological changes induced by irradiation; studies on differences in radiosensitivity among numerous plant species with reference to the significance of nuclear volume and chromosome size as affecting radiosensitivity and a derived method of predicting radiosensitivity (predicted responses are given for 33 species of higher plants); studies on the diploid vs. polyploid radiosensitivity problem as related to the so-called "protective effect of polyploidy"; studies on the relationship between radiosensitivity and the estimated DNA content per chromosome; and studies on the responses of plant species in an old field community and ecology forest subjected to chronic irradiation. Where results or experiments are not fully described, adequate lists of references are given which cover those aspects mentioned. (auth)

Radiation Effects on Microorganisms

3454 (COO-1183-17) GROWTH CHARACTERISTICS OF TYPE E CLOSTRIDIUM BOTULINUM IN THE TEMPERATURE RANGE OF 34 TO 50 F. (Continental Can Co., Inc., Chicago, Ill.). Oct. 3-4, 1966. Contract AT(11-1)-1183. 7p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Spore suspensions incubated at 46° and 50°F. showed somewhat shorter outgrowth times in ground haddock than spores produced at 85°F. Toxin assay procedures for spores in ground haddock are described. Studies on development of toxin in irradiated and unirradiated fresh fish in the refrigeration temperature zone are described. (H.L.W.)

3455 SURVIVAL OF TWO STORAGE FUNGI AFTER GAMMA RADIATION OF HOST SEEDS. Kulik, M. M.; Justice, O. L. (Agricultural Research Service, Dept. of Agriculture, Beltsville, Md.). Radiat. Bot., 6: 407-12(Oct. 1966).

Seeds of Allium cepa L., Raphanus sativus L., Poa pratensis L., Trifolium incarnatum L., Sorghum vulgare Pers., Triticum aestivum L. and Zea mays L. were inoculated with spores of Aspergillus amstelodami (Mangin) Thom and Church prior to irradiation. Arachis hypogaea L. seeds were inoculated with spores of Aspergillus flavus Link before they were irradiated. Inoculated and non-inoculated seeds were exposed to doses of 0, 5, 10, 20, 40 or 80 krad of γ-radiation from a ^{60}Co source. Some destruction of A. amstelodami and A. flavus apparently occurred at 80 krad. At this exposure, however, the seedling-production potential of all crop species, with the possible exception of Trifolium incarnatum and Raphanus sativus, was greatly reduced. In general, the fungi were found to be more resistant to radiation injury than the seeds. Storage of inoculated, irradiated seeds under conditions favorable to the growth of storage fungi yielded no clear-cut picture of the effect of γ-radiation on the subsequent behavior of A. amstelodami (or A. flavus on Arachis hypogaea) in stored seeds. (auth)

3456 MUTANTS OF ESCHERICHIA COLI VARIABLY RESISTANT TO BACTERIOPHAGE T1. Carta, Guy R.; Bryson, Vernon (Rutgers State Univ., New Brunswick, N. J.). J. Bacteriol., 92: 1055-61(Oct. 1966).

Mutants resistant to bacteriophage T1 were isolated from uv-irradiated cultures of Escherichia coli B/r, a uv-resistant variant. Bacterial populations derived from some of these mutants were partially but not completely resistant to the bacteriophage. Such mutants, designated variably resistant (B/r/lv), could not be obtained from E. coli B. Phage-free mutant populations taken from different stages in growth consisted of significantly different proportions of T1-resistant and T1-sensitive cells. The growth stage-dependent range of variation exceeded 1,000-fold. In broth cultures, the highest proportion of resistant cells consistently appeared at mid-log phase, and the highest proportion of sensitive cells at lag and stationary phases. Comparable evidence for environmentally dependent changes in host-cell phenotype was obtained by efficiency of plating and cloning efficiency analysis tests. Micromanipulation showed that, in clones growing in the presence of phage T1, sensitive bacteria appeared with high frequency and underwent lysis. (auth)

3457 ULTRAVIOLET RADIATION STUDIES OF FILAMENTOUS ESCHERICHIA COLI B. Kantor, George J.; Deering,

R. A. (Pennsylvania State Univ., University Park). J. Bacteriol., 92: 1062-9(Oct, 1966).

Small uv doses cause Escherichia coli B to grow into long filamentous single cells. A large fraction of these filaments can recover their division ability and can form colonies under appropriate conditions. Preformed filaments can be irradiated with uv, and their ability to still produce colonies can be compared with that of irradiated normal cells. In this regard, filaments are more sensitive to uv than normal cells. Filaments can still host-cell reactivate uv-irradiated T1 phage and can regain their own DNA synthetic ability after it has been blocked by uv. This indicates that these filaments still retain mechanisms for repairing uv-damaged DNA. Pantoyl lactone, an agent that stimulates cell-division recovery in uv-irradiated E. coli B, causes increased uv resistance for both normal and filamentous cells, with the filaments becoming more resistant than normal cells. In the absence of pantoyl lactone, irradiated filaments grow to a length of about 50 times normal and then stop growing. These long filaments cannot subsequently divide and give colonies. It is concluded that the uv dose given to the preformed filaments causes an additional division lag beyond that of unirradiated filaments, and that some critical length is reached after which division recovery and colony formation is impossible. Irradiated normal cells recover before reaching this critical length. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstract 3012.

3458 (ALO-3632-7) RESEARCH AND DEVELOPMENT IN A THERMAL INSULATION STUDY. Quarterly Progress Report, July-September 1966. DeWitt, W. D. (Union Carbide Corp., Indianapolis, Ind. Linde Div.). Oct. 28, 1966. Contract AT(30-1)-3632. 65p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Small-scale and large-scale processing tests were completed for the candidate insulation materials except for Ta flake-opacified quartz fiber paper which will be received in the next reporting period. Physical stability tests were completed for these insulation materials. Problems encountered in the establishment of pressure at less than 0.5μ of Hg in the offgassing chamber at 1800°F necessitated the design and fabrication of a new chamber. Preceding solution of the high-temperature operation problem, initial offgassing tests are being conducted at 1000°F. The mass spectrometer gas analyzer was installed. Fabrication of the thermal conductivity testers was completed, and a thermal conductivity test of the insulation composite Ni foil-quartz cloth was initiated. A review of heater element design and selection is under way because of difficulties encountered in the handleability of W wire. Calculations were made to determine an optimum layer density of the insulation composite Al foil–glass fiber paper. Results of technical discussions indicated that the problem of oxidation remains as the most significant one and the use of superalloys appears feasible. A detailed test procedure for the vacuum enclosure task was developed, candidate enclosure test specimens designed, and a design of the test apparatus prepared. Preliminary insulation dynamic tests were successfully completed for the planned insulation composites with the exception of the Ta–Ta flake opacified quartz fiber paper composite. No visual damage to any of the insulation composites tested was observed. The tasks to be performed during the next quarterly reporting period are discussed. (auth)

Corrosion and Erosion

3459 (AECL–2619) USE OF ZIRCONIUM ALLOYS IN ORGANIC COOLANTS. Boulton, J. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Sept. 1966. 18p. Dep. mn. AECL $1.00.

The behavior of some zirconium alloys in organic coolants is summarized. By maintaining the water concentration of the coolant in excess of 50 ppM and careful control of chlorine contamination, it is shown that the rate of hydriding of low-Ni Zircaloy-2 or Zircaloy-4 and Zr–2.5% Nb alloy can be held to reasonable limits. It is estimated that Zircaloy-4 or Zr–2.5% Nb alloy should have useful lives, as pressure tube materials, of at least 5 years under WR-1 operating conditions and with Zr–2.5% Nb alloy a useful life of over 1 year as fuel cladding in WR-1. The behavior of a Zr–0.7% Cu–0.2% Fe alloy and Ozhennite 0.5 is also described. Ozhennite 0.5 shows much promise for future development as a possible pressure tube material for organic-cooled reactors. (auth)

3460 (AEET–260) COMPATIBILITY STUDIES ON ZIRCONIUM ALLOYS IN SANTOWAX-OM AT 750 DEG F. Singh, Sohan; Gnanamoorthy, J. B.; Balachandra, J. (Atomic Energy Establishment, Trombay (India). Metallurgy Div.). 1966. 14p. Dep. mn.

The following alloys were tested in the α-annealed state: Kroll zirconium, Zr–1% Cu–1% Fe, Zr–1% Cr, Zr–2% Cr, Zr–2% Fe, and Zr–2% Cu. The testing was carried out under static conditions in Santowax OM containing 30 to 100 ppM H_2O for 10 to 90 days. Weight gains and hydridations were measured, and the surface effects were determined metallographically. The alloys showing the best compatibility were Kroll Zr and the alloys containing Cr. The similarity of the corrosion in Santowax OM to that in steam suggests that the moisture plays an important role. (D.L.C.)

3461 (WERL–2823-23) THE ADSORPTION OF OXYGEN ON TUNGSTEN AT TEMPERATURES FROM 300 TO 850 DEG K. Paper 66-9E1-441-P4. Singleton, J. H. (Westinghouse Research Labs., Pittsburgh, Pa.). Oct. 24, 1966. Contract AT(30-1)-2823. 39p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The adsorption of oxygen was studied on a polycrystalline tungsten ribbon, at temperatures from 300 to 765°K. Two types of tungsten surface structure were distinguishable by their adsorption and desorption behavior. At 300°K, adsorption on either type of surface occurred into a single phase, but, at higher temperatures, to a maximum of ~765°K, additional adsorption occurred, with an energy of activation of ~0.25 eV. This process probably involves a reconstruction of the tungsten surface rather then the adsorption into a pre-existing set of sites. Solution of oxygen is observed at temperatures between 800 and 1000°K, and the data are consistent with the model of a process restricted to the surface layers of the tungsten. The removal of adsorbed oxygen, in a high-temperature flash, occurs only by oxide evaporation below ~1650°K and by evaporation of both an oxide and oxygen, above this temperature. (auth)

3462 (WERL-3203-5) HYDROGEN REACTIONS WITH ALLOYS OF ZIRCONIUM AND THE METALS VANADIUM, CHROMIUM, IRON, COBALT, NICKEL, COPPER, MOLYBDENUM, AND NIOBIUM. Annual Report, June 1, 1965–March 1, 1966. Gulbransen, E. A.; Pebler, A. R.; Andrew, K. F. (Westinghouse Research Labs., Pittsburgh, Pa.). Contract AT(30-1)-3203. 32p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

A program is being conducted to study the nature and mechanism of the reactions of Zr alloys with water vapor at 300 to 600°C. Summaries are presented of work done in the following areas: rebuilding of the hydrogen absorption apparatus, thermochemical and structural aspects of the reactions of hydrogen with alloys and intermetallic compounds of Zr, hydrogen analysis of oxidized Zr and its alloys, and oxidation studies at 500°C on Zr, Zircaloy II, and Zircaloy IV. A paper on equilibrium studies on the Zircaloy IV–hydrogen system between 350 and 700°C is also included. (D.L.C.)

3463 OXIDATION CHARACTERISTICS OF VAPOR-PLATED TUNGSTEN. Nieberlein, Vernon A. (Army Missile Command, Redstone Arsenal, Ala.). Corrosion, 22: 291-3(Oct, 1966).

Vapor-deposition is being used increasingly for fabricating complex shapes from W. In contrast to conventional W whose oxidation kinetics were explored, vapor-deposited material has never been investigated systematically with regard to oxidation. Oxidation rates were run at 600 to 1000°C in air using a recording balance. Activation energies were calculated and oxidation rates were compared with those of W sheet prepared using powder metallurgy techniques. Humid air and dry air were compared as corroding media. (auth)

3464 KINETICS OF OXYGEN CHEMISORPTION ON THE SURFACE OF THIN MOLYBDENUM LAYERS. Lazarov, D. (Sofia Univ.). Compt. Rend. Acad. Bulg. Sci., 19: No. 1, 41-4 (1966).

The kinetics of gas adsorption on the surface of solids follows in a number of cases the Yelovich equation $V = (dn/dt) - a.e^{-bn}$, where V is the rate of the process, a denotes the rate at the beginning of the chemisorption process, b is a constant, and n the molecules adsorbed up to a given moment. Data on chemisorption processes may be obtained by measuring the changes in conductivity of adsorbed layers. If the process is carried out at various temperatures, its activation energy may be calculated from the obtained data by using the Yelovich equation and $a = k.e^{-E_0/RT}$, where E_0 denotes the activation energy at the beginning of the chemisorption process and k is a constant almost dependent on temperature. Results indicate the possibility of finding physicochemical characteristics from the kinetics of chemisorption process on the surface of thin metal films. Results, however, may be considered absolutely correct only in the case when the relationship between absorbed amount and the changes in the layer's resistance is actually linear and is not significantly affected by the temperature. (JPRS)

Preparation and Fabrication

3465 (CEND–3742-288) VANADIUM PURIFICATION. Quarterly Progress Report No. 1, July 1–September 30, 1966. Worcester, S.; Christopher, S. S. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Nov. 1966. Contract AT(30-1)-3742. 39p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A series of experiments was conducted to determine the most effective gettering element for purifying high interstitial V. The gettering elements evaluated were Al, Si, and Y. In addition to the preparation of unalloyed button melts of V, alloys containing 0.5, 1.0, and 1.5 wt % of each of the gettering elements were melted. For every composition, two buttons were arc melted. One button of each composition was subsequently remelted in an electron beam button furnace. All buttons were then evaluated for chemical composition, room temperature hardness, and microstructure. Preliminary data from this phase of the program are discussed. (auth)

3466 (EURAEC-1521) FURNACE IN CAISSON FOR THE FABRICATION OF U–Pu ALLOYS. Special Report No. 30. Mercier, C. (Commissariat a l'Energie Atomique, Paris (France)). Aug. 1965. 45p. (EUR-2673). Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Work Performed Under United States–Euratom Joint Research and Development Program.

A description is given of part of the CADARACHE plant which was used to fabricate U–Pu fuel rods for substitution experiments in CEA reactors. A standard-model (IS 2 type HERAEUS) induction furnace was placed inside a tight caisson and operated by workers in frog suits. The joints used are described, and the mode of operation is analyzed, showing the weak spot to be the small decontamination chamber. It is concluded that it is feasible to use a tight caisson for equipment too large to be fitted into a glove box. (D.L.C.)

3467 (EURAEC-1692) STAINLESS STEEL CLADDING OF HEAVY GAGE STEELS. Quarterly Report No. 7, January 1 to March 31, 1966. (NERATOOM, N. V., The Hague (Netherlands). Ghent Rijksuniversiteit (Belgium). SOUDOMETAL, S. A., Brussels (Belgium)). Contract 008-63-12 IEEB(RD). 14p. (EUR-2879). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Work Performed Under United States-Euratom Joint Research and Development Program.

Welding techniques are being developed for the cladding of steel plates and shells with stainless steel tape. Welding parameters were determined for the deposition of single layers of AISI 308 ELC, and a composition-correcting flux was selected. Data on the chemical composition of the deposits are included. Results of the cladding of an inner shell surface with 304 ELC are also given. (D.L.C.)

3468 (UCRL–14513) PREPARATION OF MACRO-AMOUNTS OF PURE AMERICIUM METAL. Wade, W. Z.; Wolf, T. (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 2, 1966. Contract W-7405-eng-48. 27p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The process technology developed to produce ultrapure ^{241}Am metals in relatively large quantities is described. A total of 166.7 g of ^{241}Am was processed in 13 separate reduction runs. Purity ran as high as 99.99%, and yield efficiency as high as 93%. (auth)

3469 STRAIN-ANNEAL METHOD OF GROWING CRYSTALS OF ALPHA URANIUM. Volman de Tanis, Sara; Ambrosis de Libanati, Nelly H. (Comision Nacional de Energia Atomica, Buenos Aires). J. Inst. Metals, 94: 395-6(Nov. 1966).

Samples of high-purity electrolytic uranium were subjected to several different preparation schedules to produce tensile specimens with various initial grain sizes. Groups of specimens of the same grain size were strained in tension by various amounts and were then annealed for 48 hr at 630°C. Stress–strain curves were recorded and analyzed. It was observed that the transition strain derived from each plot coincides with the corresponding critical strain for recrystallization to a single grain. (A.G.W.)

3470 PREPARATION OF THIN SELF-SUPPORTING BORON FILMS USING A HEATED SUBSTRATE. Arnison, G. T. J.; Gilmour, R. J. Nucl. Instrum. Methods, 45: 178(Nov.-Dec. 1966).

It was found that the method of Muggleton and Howe (Nucl. Instr. Methods, 13: 211(1961)) for the production of thin self-supporting boron films can be made more reproducible and operator-independent by using a fixed evaporation rate and by heating the substrate. (D.C.W.)

3471 MICROELECTRONICS USING TANTALUM FILM TECHNOLOGY. Fresh, D. L.; Beck, R. L. (Collins Radio Co., Newport Beach, Calif.). pp 181-6 of Proceedings of the National Electronics Conference. Vol. XXII. Chicago, National Electronics Conference, Inc., 1966.

Preparation of hybrid thin-film Ta microelectronic circuits is described. Resistor components are Ta metal while the capacitors consist of Ta electrodes with anodically oxidized Ta serving as the dielectric. Vacuum-evaporated Al film serves as the interconnecting pattern. Transistors, diodes, and semiconductor-integrated circuits are attached to the substrates and leads are bonded between these devices and appropriate locations on the Al pattern. The assembly is mounted in a ceramic package. (J R.D.)

3472 ELECTRON BEAM EVAPORATION TO PROMOTE WETTING BY LIQUID METALS. Weiss, Stanley; Gilliland, R. Gerald; Brush, Edwin F.; Adams, Clyde M. Jr. (Massachusetts Inst. of Tech., Cambridge). pp 985-90 of Proceedings of the National Electronics Conference. Vol. XXII. Chicago, National Electronics Conference, Inc., 1966.

The most effective wetting reagent found in an investigation of brazing hard-to-wet materials is Ti. This element promotes wetting of a large number of solid surfaces by a wide variety of liquid metals. Wetting and flowing of brazing alloys on Ti-coated base material occurs by liquid metal penetration, displacement, and tunneling under vapor-deposited films. (J.R.D.)

3473 SOLUBILITY OF TANTALUM AND TUNGSTEN IN LIQUID RARE EARTH METALS. Dennison, D. H.; Tschetter, M. J.; Gschneidner, K. A. Jr. (Ames Lab., Ames, Iowa). J. Less-Common Metals, 11: 423-35(Dec. 1966). (IS–1363).

The solubilities of tantalum in eight liquid rare earth metals (Y, La, Ce, Pr, Nd, Sm, Eu and Yb) and of tungsten in all the liquid rare earth metals (except Pm) have been measured from 1325° to 2150°C. These data show that tungsten is a much better crucible material for the rare earth metals than tantalum, since tungsten is less soluble than tantalum in the liquid rare earth metals by a factor ranging from 2 for Sc and the heavy lanthanides to 10 or greater for the light lanthanides. The solubilities of both tantalum and tungsten at a given temperature vary inversely with the atom sizes of the rare earth solvents. Furthermore, it was found that the solubility change for a given size increment is much larger if the size factor is less than a critical value (about 17.5% for the Ta alloys and 20% for the W alloys), than if the size factor is larger than the critical value. The heats of solutions were calculated from the liquidus data and were found to support the size correlation proposed by Strauss, White, and Brown for liquid alloys. (auth)

3474 PLATING BY MEANS OF WELDED FACINGS OF SEALING AND SLIDING SURFACES IN AN ATOMIC REACTOR. Bucholz, Obering A. Fachbuchreihe Schweisstech., 40: 166-9(1964). (In German).

Research on the possibility of electrically welding cemented plates on large sealing surfaces used in nuclear reactors and on plating by means of welded facings is reported. It was established that precise maintenance of the welding conditions and welding temperatures and careful performance of subsequent heat treatment are required. All the problems to be expected in plating by means of welded facings are not reported. (tr-auth)

3475 METALLOTHERMIC REDUCTION OF BERYLLIUM OXIDE. Campbell, T. T.; Mussler, R. E.; Block, F. E. (Albany Metallurgy Research Center, Oreg.). Trans. Met. Soc. AIME, 236: 1456-61(Oct. 1966).

An exploratory study was made to determine the feasibility of preparing Be by the metallothermic reduction of BeO. The procedure involves heating a nonvolatile metal reductant in contact with BeO in a vacuum. Be vapors formed in the reaction are condensed as a coherent deposit on a heated surface. Reductants tested include La, Y, Th, Th–Mg, and Zr–Ti alloys, and the hydrides of La, Y, and Zr. Test temperatures ranged from 1350 to 1750°C, and reaction times ranged from 30 to 100 hr. In most cases metal recoveries were low, although yields of 90% of theoretical were obtained with La, Y, and Zr reductants. In most cases metal deposits were contaminated by beryllides, usually of the Be_{12} M or Be_{13} M type. (auth)

3476 SOME CHARACTERISTICS OF ELECTRON-BEAM ZONE REFINING OF METALS. Korobochkin, Yu. M.; Pautov, V. D.; Shiryaev, V. I. Izv. Akad. Nauk SSSR, Metal., No. 1, 73-9(Jan.-Feb. 1966). (In Russian).

The basic units of the electric part of the apparatus were a Type FRS ferroresonance stabilizer, a high voltage transformer, a Type RNO-250-2 regulating autotransformer, and two Type TRI-6/15 thyratrons fed by heating transformers. A high voltage was applied to the sample, which formed the anode. The emission current could be uniformly regulated from 0 to 300 mA. As a result of the evolution of gases and the vaporization of impurities, the emission current varied within wide limits and made the melting process difficult, sometimes even leading to an electrical discharge and to fracture of the sample. The mechanical part of the apparatus (illustrated) made possible movement of the annular irradiation unit at the required rate, as well as rotation of the sample. A Type D-104 motor (33 rpm) was used to displace the cathode. A reducer permitted varying the rate from 0.04 to 1.2 rpm, which corresponded to a change in the rate of movement of the cathode from 10 to 300 mm/hour. The annular electron irradiation unit was made of tungsten filament and surrounded the sample. The optimum diameter of the annulus was 25 to 30 mm. Zone melting experiments were carried out on a number of metals: iron, nickel, copper, molybdenum, tungsten, vanadium, niobium, and titanium, as well as on iron–nickel, iron–nickel–chromium, and other alloys. It was impossible to use this apparatus for melting metals that have a high vapor pressure because of discharges between the anode and the cathode. The results of the experiments are shown in curves and microphotographs. (ATD)

3477 ZONE REFINING OF MOLYBDENUM. Kovtun, G. P.; Kruglykh, A. D.; D'yakov, I. G. Izv. Akad. Nauk SSSR, Metal., No. 1, 71-2(Jan.-Feb. 1966). (In Russian).

The effect of certain parameters of zone recrystallization (speed of travel of the liquid zone, number of passes) on the degree of refining of molybdenum was studied. The metal purity was determined by measuring the ratio of the electrical resistance at room temperature to that at the temperature of liquid helium. The zone refining was done with a special electron-beam gun whose design is described. It was noted that the refining of molybdenum is due mainly to the vaporization of volatile impurities, and also to the mechanism of zone refining itself. The character of the distribution of impurities over the length of the specimen indicates that molybdenum contains many impurities with a distribution coefficient $K < 1$, such as carbon. A change in the speed of travel of the liquid zone from 1 to 5 mm/min does not appreciably affect the distribution of impurities along the specimen. (ATD)

3478 DETERMINATION OF THE SIZE OF PARTICLES OF FINELY DISPERSED METAL POWDERS. Panichkina, V. V.; Skorokhod, V. V. Porosh. Met., Akad. Nauk Ukr. SSR, No. 9, 1-5(Sept. 1966). (In Russian).

The results of a determination of the specific surface by the method of gas flow ratio and curves of particle distribution according to size by the turbidimetric method for finely dispersed nickel, tungsten, and molybdenum powders are presented. Comparison of these data and values obtained by other methods permits recommending the above-mentioned methods for industrial control of dispersity. (auth)

3479 METHOD OF PREPARING URANIUM FOR NICKEL PLATING. Lundquist, Jerry R.; Stromatt, Robert W. (to U. S. Atomic Energy Commission). U. S. Patent 3,275,535. Sept. 27, 1966.

A method of preparing U for electro plating is described. After cleaning, the U is anodized in an aqueous solution which is 5 to 7 M H_2SO_4 and 0.25 to 0.40 M HCl. Improved adhesion of the plating is obtained and satisfactory coverage is obtained, as a thinner plate. The process is a desirable preliminary to the hot-die-sizing method of canning U fuel elements. (auth)

3480 METHOD FOR PRODUCING ULTRA HIGH PURITY PLUTONIUM METAL. Leary, Joseph A.; Mullins, Lawrence J. Jr. (to U. S. Atomic Energy Commission). U. S. Patent 3,281,338. Oct. 25, 1966.

An invention concerned with a method for reducing the reflector metal impurities in the electrorefining operation of Pu metal by coating the cathode with stable, electrically conducting compounds such as the carbides, nitrides, and borides of Ta, Hf and Nb is described. (auth)

Properties Evaluations

Refer also to abstracts 3512, 3925, and 3926.

3481 (AGN-8192(Vol.5)) ALKALI METALS EVALUATION PROGRAM. THE SPECIFIC HEAT OF LIQUID CESIUM. Achener, P. Y.; Fisher, D. L. (Aerojet-General Nucleonics, San Ramon, Calif.). Sept. 1966. Contract AT(04-3)-368. 28p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The enthalpy and specific heat of liquid cesium at temperatures between 1200 and 1850°F are reported. The experimental method involved the use of a Bunsen ice calorimeter. The equation proposed for the enthalpy of liquid cesium from the melting point to 2000°F is: $H^0_T - H^0_{32°F} = 7.60 + 0.0550T$ Btu/lb where T is in degrees Fahrenheit. The resulting value for the specific heat liquid cesium is $C_p = 0.0550$ Btu/lb °F. (auth)

3482 (EURAEC-1645) [MECHANICAL PROPERTIES OF STEELS]. Quarterly Report No. 6, January-March 1966. (Compagnie des Ateliers et Forges de la Loire, Paris (France). Department des Recherches). Contract 033-64-9 TEE F (RD). 125p. (EUR-2843). Dep. mn. CFSTI $4.00 cy, $0.75 mn.

Work Performed under United States-Euratom Joint Research and Development Program.

Embrittlement tests with and without stress, creep tests, and stress-corrosion tests were, or are being, conducted at high temperatures on austeno-ferritic and austenitic steels. The stress-corrosion tests were made in solutions of $MgCl_2$, dilute chlorides at different pH, soda, and $FeCl_3$. The steels tested include Uranus 50, Uranus 50 Si, Uranus ST, Uranus ST Si, Uranus S, Uranus SD, ICN 472 BC, ICN 164 BC, and Krupp V II A. (D.L.C.)

3483 (EURAEC-1714) RESEARCH TO DETERMINE THE LONG-TERM MECHANICAL PROPERTIES OF METALS SUBJECTED TO MECHANICAL STRESS AT ELEVATED TEMPERATURES AND NEUTRON IRRADIATION. Quarterly Report No. 14, April 1-June 30, 1966. Siegfried, W.; Zimering, S. (Battelle Memorial Inst., Geneva (Switzerland)). Sept. 1966. Contracts 100-62-12 RDS; 057-64-7 TEES (RD). 8p. (EUR-2895). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Work Performed under United States-Euratom Joint Research and Development Program.

A summary is given of work done in the following areas: (1) relationship between the time-to-rupture curves and the various classes of mechanism taking place during the rupture process; (2) time-to-rupture tests on pure iron; (3) application of the exponential function of real order to the extrapolation of time-to-rupture tests; and (4) application of investigation methods to time-to-rupture tests under neutron irradiation. (D.L.C.)

3484 (MCW-1504) URANIUM TEXTURE EVALUATION STUDIES, 1963-1966. Stoeker, William C.; Starbuck, James W. (Mallinckrodt Chemical Works, Weldon Spring, Mo. Uranium Div.). Aug. 1, 1966. Contract W-13-108-eng-8. 42p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Sampling procedures permitting appraisal of axial and circumferential textures are assessed and employed in studies of alloy content versus mode of cooling from beta phase heat treatment. Oil quenching or isothermal transformation at about 500°C yield the most random structures in extruded core blanks. An automated diffractometer provides texture values that are equivalent in precision to manually generated data. Circumferential texture variance within centrifugally cast core blanks is associated with the appearance of grain clusters in the macrostructure and may be minimized by isothermal transformation at the upper nose of the TTT diagram for the alloy involved. (auth)

3485 (MSAR-66-220) EFFECT OF HIGH TEMPERATURE SODIUM ON AUSTENITIC AND FERRITIC STEELS. MECHANICAL PROPERTIES OF MATERIALS. Quarterly Progress Report, July-September 1966. (MSA Research Corp., Evans City, Pa.). Oct. 1966. Contract AT(11-1)-765. 30p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The status of Tests 6 and 7 (304 stainless steel in 1200°F sodium contaminated with oxygen or carbon) is discussed. The testing of LVDT's for the liquid-metal extensometer system showed failure above 800°F due to electrical breakdown in the insulators. Data are presented for the analyses of the cold traps from Tests 3 and 5. (D.L.C.)

3486 (N-66-29521) CHANGES IN PHOTOELECTRIC WORK FUNCTION OF MOLYBDENUM DUE TO ADSORPTION OF CARBON MONOXIDE. Clewley, John Dean (Vermont Univ., Burlington). Apr. 1966. 50p. (NASA-CR-75865). CFSTI $3.00 cy, $0.65 mn.

Thesis.

The photoelectric work function of a polycrystalline molybdenum sample in both the clean state and during chemisorption of carbon monoxide was found experimentally. The experimental procedure is outlined and results are compared to previous work and predicted values. A decrease in the rate of change of work function of molybdenum on exposure to carbon monoxide after ion bombardment is attributed to mechanical roughening of the surface during bombardment. Background discussion is presented in the fields of adsorption, surface physics, and photoelectric measurements. The change in surface potential due to the addition of a dipole layer is calculated. (auth)

3487 (NAS-CR-72039) DETERMINATION OF ELEVATED-TEMPERATURE FATIGUE DATA ON REFRACTORY ALLOYS IN ULTRA-HIGH VACUUM. Eighth Quarterly Report, April 1, 1966-July 1, 1966. Honeycutt, C. R.; Martin, T. F.; Sawyer, J. C. (TRW Equipment Labs., Thompson Ramo Wooldridge Inc., Cleveland, Ohio). July 15, 1966. Contract NAS3-6010. 36p.

Specimens of TZM alloy having various notch configurations were fatigue tested at 2000°F (1093°C) to determine the effect of notch geometry on fatigue strength. Above a notch factor of approximately two, stress values for fatigue failures calculated from classical notch theory produced values which were apparently below those obtained on smooth specimens. Tension-tension fatigue tests conducted on TZC alloy smooth specimens at 2000°F with a 20 ksi ($1,38 \times 10^8 N/m^2$) static load and A ratios of 0.1 to 0.4 indicated that the presence of the dynamic load significantly increased the total creep extension. At 2000°F, as much as 2.8% creep has been observed in 59 hours at a peak stress of 27.2 ksi ($1.88 \times 10^8 N/m^2$). (auth)

3488 (NAS-CR-72044) GENERATION OF LONG TIME CREEP DATA OF REFRACTORY ALLOYS AT ELEVATED TEMPERATURES. Twelfth Quarterly Report, March 26, 1966-June 26, 1966. Sawyer, J. C.; Steigerwald, E. A. (TRW Equipment Labs., Thompson Ramo Wooldridge Inc., Cleveland, Ohio). July 15, 1966. Contract NAS3-2545. 94p.

A program is being conducted to obtain long-time creep data on refractory alloys for use in advanced space power systems. Creep data were collected over test times from 1,000 to 10,000 hr in vacuum and are presented in the form of graphs and tables for the following materials and temperatures: TZC at 1856 to 2200°F, T-111 at 1860 to 2200°F, TZM at 1600 to 2000°F, Nb-modified TZM at 2000°F, and arc-melted and vapor-deposited tungsten at 2800°F. (D.L.C.)

3489 GRAIN-SIZE DEPENDENCE IN THE FLOW AND FRACTURE OF ALPHA ZIRCONIUM. Coleman, C. E.; Hardie, D. (Univ. of Newcastle upon Tyne, Eng.). J. Inst. Metals, 94: 387-91(Nov. 1966).

The grain-size dependence of the fracture and flow stresses of zirconium has been examined and found to fit the Petch equation $\sigma = \sigma_0 + kd^{-\frac{1}{2}}$. The friction stress σ_0 shows a simple exponential variation with temperature but k values are more complex. A decrease in k with increasing strain to a minimum at ~0.01 strain is explained in terms of the variation in strain-hardening characteristics with grain size. (auth)

3490 MAGNETOCRYSTALLINE ANISOTROPY OF YCo_5 AND Y_2Co_{17}. Hoffer, G.; Strnat, K. (Wright-Patterson Air Force Base, Dayton, Ohio). IEEE (Inst. Elec. Electron. Eng.) Trans. Magnet., MAG-2: 487-9(Sept. 1966).

The first measurements of the magnetocrystalline anisotropy constants of YCo_5 and Y_2Co_{17} are reported. Measurements at room temperature showed that YCo_5 has a magnetically easy $\underline{c}$ axis and $K_1 = 5.7 \times 10^7$ erg/cm^3; K_2 was not determined but is estimated to be less than 10^6 erg/cm^3. Y_2Co_{17} has an easy basal plane, and, by 3 different methods of measurement: $K_1 + K_2 = -3.0 \times 10^6$ erg/cm^3; $K_1 = -2.9 \times 10^6$ erg/cm^3, $K_2 = 0.03 \times 10^6$ erg/cm^3; $K_1 = -2.1 \times 10^6$ erg/cm^3, $K_2 = -0.1 \times 10^6$ erg/cm^3. Although Y_2Co_{17} has a favorably high saturation moment and Curie point, it cannot be used for crystal anisotropy-controlled permanent magnets, since the moments in this material are free to rotate 360° in the basal plane. On the other hand, YCo_5 has the magnetically easy $\underline{c}$ axis desired for permanent magnet application. To reverse the direction of magnetization in this material, it is necessary to force the moments through the hard basal plane. (BBB)

3491 MAGNETIC PROPERTIES OF RARE EARTH–IRON INTERMETALLIC COMPOUNDS. Strnat, K.; Hoffer, G.; Ray, A. E. (Wright-Patterson Air Force Base, Dayton, Ohio). IEEE (Inst. Elec. Electron. Eng.) Trans. Magnet., MAG-2: 489-93 (Sept. 1966).

Curie points, temperature dependence of the high-field magnetization below room temperature, saturation moments, and densities are reported for the most iron-rich compounds in the rare earth–iron systems. The heavy rare earth compounds have the composition A_2Fe_{14} and the hexagonal Th_2Ni_{17}-type structure, while the light rare earths have the stoichiometry AFe_7 and a modified rhombohedral Th_2Zn_{17} structure. From the saturation of Y_2Fe_{17} and Lu_2Fe_{17}, an iron moment of 2.0 μ_B is calculated. In these 2 compounds and in $CeFe_7$, $PrFe_7$, and, perhaps, $NdFe_7$, all atomic moments couple ferromagnetically, while for Gd_2Fe_{17} through Tm_2Fe_{17} the magnetizations of the rare earth and iron sublattices subtract. Curie temperatures range from −180°C ($CeFe_7$) through a peak of +186°C (Gd_2Fe_{17}) to −41°C (Tm_2Fe_{17}). This suggests that two exchange mechanisms are active, which make comparable contributions to the interaction energy: direct exchange between Fe atoms and indirect coupling via conduction electrons between iron and the rare earth atoms. (BBB)

3492 MAGNETIC PROPERTIES OF RARE EARTH–MANGANESE COMPOUNDS. Kirchmayr, Hans R. (Technische Hochschule, Vienna). IEEE (Inst. Elec. Electron. Eng.) Trans. Magnet., MAG-2: 493-9(Sept. 1966).

The alloys and intermetallic compounds between rare earth (RE) metals and transition metals, especially Mn, Fe, Co, and Ni are of interest because of their magnetic properties. The so-called amalgam process was used for preparing single-phased, magnetically pure specimens. Magnetic measurements on the compounds RE_6Mn_{23} (RE = Gd, Dy, Er, Y), $REMn_{12}$ (RE = Gd, Dy, Er) and $REMn_2$ (RE = Gd, Dy, Er) are reported. In all of these compounds a ferro-, ferri-, or antiferromagnetic coupling of the moments was observed. The magnetic properties of these compounds, which are discussed, can be explained by transitions between several different ferri- or ferromagnetic states, depending on field strength and temperature. (BBB)

3493 TEMPERATURE DEPENDENCE OF THE ELASTIC STIFFNESS COEFFICIENTS OF NIOBIUM (COLUMBIUM). Armstrong, Philip E.; Dickinson, James M.; Brown, Harry L. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Trans. Met. Soc. AIME, 236: 1404-8(Oct. 1966). (LA-DC-7587).

The elastic stiffness coefficients of Nb were measured at −150 to 650°C and are in accord with the anomalous temperature dependence previously observed for Young's modulus. This unusual behavior was shown to be the result of changes in the relative values of the shear elastic coefficients. The bulk modulus remained essentially constant over the temperature range studied, while changes in the shear coefficients produced a more nearly isotropic behavior as the temperature increased. (auth)

3494 ANISOTROPY OF THE HALL EFFECT IN DYSPROSIUM. Volkenshtein, N. V.; Grigorova, I. K.; Fedorov, G. V. (Inst. of Physics of Metals, Academy of Sciences, USSR). Zh. Eksp. Teor. Fiz., 51: 780-5(Sept. 1966). (In Russian).

The Hall effect is measured in single crystals of Dy (ρ(294°K)/ρ(4.2°K) = 10) at temperatures between 4.2 and 350°K. An anisotropy of the field and temperature dependences of the Hall emf is found in the temperature range of existence of magnetic ordered structure. An anisotropy of the Hall coefficients above the Neel point was also found. (auth)

3495 EFFECTS OF PROGRAMMED LOADING ON THE PLASTICITY OF BERYLLIUM MONOCRYSTALS. Gindin, I. A.; Neklyudov, I. M.; Finkel, V. A.; Shubin, Yu. V. (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Fiz. Metal. Metalloved., 21: 774-8(May 1966). (In Russian).

The effects of preliminary programmed loading at 400°C on the subsequent mechanical properties of Be monocrystals at room temperature were investigated. One set of specimens (99.6% pure, with base plane oriented at 45° to the loading axis) was loaded (0, 5, 6, and 10 kg/mm^2) and tested in compression. Another set (99.9% pure, base plane and ⟨1010⟩ direction coincided with loading axis) was loaded (0, 4.3, and 5 kg/mm^2) and tested in tension. It was found that the room temperature yield stress σ_s and relative compressibility ϵ were 9.6, 11.3, 11.0, and 9.8 kg/mm^2 and 10.7, 17.7, 24.7, and 11.2% respectively for the preloading conditions of the first set of specimens and 14.5, 16.1, and 12.4 kg/mm^2 and 29, 36, and 39.5% respectively for the second set. Elongation was 54, 53, and 64% respectively for the second set. X-ray diagrams of the preloaded monocrystals are also presented. (ATD)

3496 PECULIARITIES OF THE TEMPERATURE DEPENDENCE OF ELECTRIC RESISTIVITY OF DYSPROSIUM AT LOW TEMPERATURE. Volkenshtein, N. V.; Dyakina, V. P.; Novoselov, V. A.; Startsev, V. E. (Inst. of Metal Physics, Academy of Sciences, USSR). Fiz. Metal. Metalloved., 21: 674-7(May 1966). (In Russian).

The electric resistivity of highly purified Dy was measured over the temperature interval 1.5 to 300°K to determine the magnetic contribution to the electric resistivity as a function of temperature. The resistivity was measured on 10 × 1 × 0.5 mm strips made of distilled Dy using a cryostat. The results agree well with the theoretical predictions proposed by A. K. Mackintosh. (ATD)

3497 AGING OF BERYLLIUM–CHROMIUM AND BERYLLIUM–ZIRCONIUM ALLOYS. Dyakov, I. G.; Papirov, I. I.; Tikhinskii, G. F. (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Fiz. Metal. Metalloved., 21: 785-6(May 1966). (In Russian).

Be alloys containing 0.3% Cr or 0.3% Zr melted from 99.95%-pure Be, 99.7%-pure Cr, and 99.9%-pure iodide Zr were rolled in vacuum at 900°C, homogenized at 1050°C for 40 min, cooled at a rate of 40°/hr, and aged at 500 to 900°C for 1 to 100 hr. The criterion of aging was the relative residual electrical resistance: $\delta = R_{4.2°K}/R_{20°C}$. Homogenized Be–0.3% Cr and Be–0.3% Zr alloys had a δ of (5.4 to 59) × 10^{-2} and (6.3 to 6.5) × 10^{-2}, respectively. The optimum aging temperatures, corresponding to a minimum δ, were 600 and 625 to 650°C for Be–0.3% Zr and Be–0.3% Cr alloys, respectively. The absolute decrease of δ in aging Be–0.3% Cr alloy was close to the decrease of δ for the initial distilled Be, which indicated a practically complete precipitation of Cr from the matrix with aging. In Be–0.3% Zr alloy, Zr apparently not only completely precipitated from the matrix, but also promoted precipitation of other impurities. Complete segregation of Cr and Zr occurred in 4 hr at 650 to 700°C and in 1 hr at 800°C. At temperatures higher than 825°C (for Be–Cr alloy) and 850°C (for Be–Zr alloy) decomposition of the secondary phases begins, which leads to an increase in the electrical resistance. The solubility limit of Cr in Be–0.3% Cr alloy and of Zr in Be–0.3% Zr alloy is at a temperature above 850 and 900°C, respectively. (ATD)

3498 THERMAL STABILITY OF TUNGSTEN CARBIDE–COBALT ALLOYS. Tumanov, V. I.; Goldberg, Z. A.; Chernyshev, V. V.; Pavlova, Z. I. Porosh. Met., Akad. Nauk Ukr. SSR, No. 10, 71-7(Oct. 1966). (In Russian).

The resistivity of WC–Co alloys with various Co contents to multiple thermal cyclings was investigated. The appearance of superficial cracks and decrease in ultimate strength during bend-

ing was the criterion of thermal stability. The effect of Cr, Mo, and Ti on thermal stability is shown and some considerations are advanced as to the mechanism of resistance to thermal shocks. (auth)

3499 EVAPORATION RATE OF BERYLLIUM DURING DISSOCIATION OF CERIUM BERYLLIDE. Amonenko, V. M.; Kruglykh, A. A.; Pavlov, V. S.; Tikhinskii, G. F. Izv. Akad. Nauk SSSR, Metal., No. 1, 190-2(Jan-Feb. 1966). (In Russian).

The results of an investigation of the evaporation rate of Be during the thermal dissociation of the intermetallic compound $CeBe_{13}$ and of the effect of the addition of a small amount (0.4 wt %) of Ce on the evaporability of Be are presented. $CeBe_{13}$ was obtained by the vacuum heating of a stoichiometric mixture of the powders of Ce and Be at 1150°C for 3 hr, while the Be–0.4% Ce alloy was obtained by direct vacuum melting of the metals. The sublimation rates of the Be–0.4% Ce alloy and of the products of dissociation of $CeBe_{13}$ were determined by the method of evaporation from a cylindrical tantalum crucible with a residual gas pressure of $\leq 2 \times 10^{-6}$ mm Hg in the vacuum chamber. The temperature was measured with the aid of an optical pyrometer correct to ±5%. Weighing of the crucibles was carried out correct to ±0.0001 g by the continuous method on scales without violating the vacuum. The sublimation rate of Be with 0.4% Ce was measured in the temperature range 920 to 1160°C; for this temperature range the saturated vapor pressure of Be over the Be–0.4% Ce alloy is described by the equation: $\log P = 9.35 - 17{,}000/T$. As for the sublimation rates of the components of the intermetallic compound $CeBe_{13}$, during its thermal dissociation in the temperature range 1050 to 1250°C, the roentgenograms of the condensates gathered following evaporation of the compound at 1100 and 1250°C lack the lines of Ce and $CeBe_{13}$; therefore, appreciable dissociation occurs above 1050°C and the entire sublimated matter may be referred to Be. The saturated vapor pressure of Be over the $CeBe_{13}$ compound during the latter's thermal dissociation may be described by the equation: $\log P = 10.475 - 18{,}990/T$. The findings were utilized to plot curves of the saturated vapor pressure of the compounds and their components. (ATD)

3500 PHYSICAL AND MECHANICAL PROPERTIES OF ALLOYS OF THE Ti–Nb–Mo SYSTEM. Kalinin, G. P.; Elyutin, O. P.; Mamontovskaya, L. V. Izv. Akad. Nauk SSSR, Metal., No. 2, 125-30(Mar.-Apr. 1966). (In Russian).

The concentration dependences of some physical and mechanical properties of alloys in the titanium corner of the Ti–Nb–Mo system were studied on alloys containing up to 50% Nb and 40% Mo. The electrical resistance, its temperature coefficient, thermal conductivity, thermal emf, modulus of normal elasticity, strength, hardness, and plasticity were determined by plotting the corresponding composition vs property diagrams. Two regions of alloys are distinguished: one has low strength properties and a low plasticity, and one has a high strength and a satisfactory plasticity. The first group of alloys with a strength of 97 to 102 kg/mm^2 and a plasticity of 9 to 14% includes Ti–Nb alloys with 30 to 35% Nb, Ti–Mo alloys with 10 to 13% Mo, and intermediate ternary alloys Ti–Nb–Mo. The alloys are located at the boundary of the region of the martensitic transformation. The group of alloys with a satisfactory plasticity includes binary Ti–Nb alloys with 45 to 55% Nb, binary Ti–Mo alloys with 20 to 25% Mo, and intermediate ternary alloys Ti–Nb–Mo, located at the boundary of $(\alpha + \beta)$ β-phase regions. These alloys have an ultimate strength of 51 to 92 kg/mm^2 and an elongation of 15 to 17%. (ATD)

3501 PROPAGATION OF A CRACK FILLED WITH LIQUID METAL. Robertson, W. M. (North American Aviation Science Center, Thousand Oaks, Calif.). Trans. Met. Soc. AIME, 236: 1478-82(Oct. 1966).

The rate of crack propagation through a solid metal in the presence of a liquid metal was calculated. The crack is assumed to propagate by solution of the solid in the liquid under the influence of an applied stress, with volume diffusion of the dissolved solute through the liquid controlling the propagation. The calculated velocities can be tens of cm per sec or higher. (auth)

3502 THERMOPHYSICAL PROPERTIES OF HEAT-RESISTANT VR-27-VP TUNGSTEN–RHENIUM ALLOY. Peletskii, V. E.; Voskresenskii, V. Yu. (Scientific Research Inst. of High Temperatures, USSR). Teplofiz. Vysok. Temp., 4: 296 (Mar.-Apr. 1966). (In Russian).

The thermophysical properties of W–Re alloy (27% Re) were determined. The vacuum-arc melted alloy (melting temperature 3300°K; recrystallization range 1800 to 2200°K) had a tensile strength of 30 to 35 kg/mm^2 at 1800°K and approximately 15 kg/mm^2 at 2100°K. Forged and polished specimens vacuum annealed for 2 hr at 2200°K and investigated in vacuum (1 to 5) $\times 10^{-5}$ mm Hg at 1200 to 3000°K had a thermal conductivity of 54.4 to 67.7 wm^{-1}/deg^{-1}, a resistivity of 60.4 to 107.2 $\times 10^6$ ohm/cm, an integral hemispherical emissivity of 0.211 to 0.347, and a monochromatic emission (at wavelength 0.65 μ) of 0.434 to 0.402. (ATD)

3503 SELF-DIFFUSION AND DIFFUSION MECHANISMS IN TUNGSTEN. Neumann, G. M.; Hirschwald, W. (Freie Univ., Berlin). Z. Naturforsch., 21a: 812-15(June 1966). (In German).

The diffusion of W into polycrystalline W (grain size 0.1 to 0.2 mm) was investigated at 1,740 to 2,100°C using the radioisotope ^{185}W. The diffusion in this temperature range follows principally the grain boundaries and can be described by the relation $D = 1.80 \times 10^{-3} \exp[-93{,}100/(RT)]$. For diffusion at high temperatures ($T > 0{,}8\ T_m$) a diffusion mechanism based on the formation and migration of double vacancies is proposed. (tr-auth)

3504 SURFACE DIFFUSION OF TUNGSTEN. Neumann, G. M.; Hirschwald, W.; Stranski, I. N. (Freie Univ., Berlin. Max-Planck-Gesellschaft, Berlin). Z. Naturforsch., 21a: 807-11 (June 1966). (In German).

The surface migration of W to W was investigated using the radioactive isotope ^{185}W. At 1700 to 2300°C the relation $D = 1.1 \times 10^{-3} \exp[-31{,}600/(RT)]$ was found for the coefficient of surface diffusion. The measured displacement energy corresponds to the values estimated by the Stanski and Suhrmann method for surface transition. Similar calculations for a series of metals show a very good agreement of the calculated activation energies with experimental data from the literature. (tr-auth)

3505 MAGNETIC CHARACTERISTICS OF SOME I:I COMPOUNDS OF THE LANTHANIDES WITH GOLD AND ALUMINUM. Kissell, F.; Wallace, W. E. (Univ. of Pittsburgh). J. Less-Common Metals, 11: 417-22(Dec. 1966).

The magnetic susceptibilities of LnAl compounds (with Ln = La, Ce, Pr and Nd) and of LnAu compounds (with Ln = any lanthanide with Gd through Yb) were determined from 2 to 300°K. LaAl is a Pauli paramagnet. The other Al compounds exhibit Curie–Weiss behavior with paramagnetic moments close to that of the corresponding free tripositive lanthanide ion. They order antiferromagnetically at temperatures ranging from 10 (for CeAl) to 25°K (for NdAl). CeAl exhibits metamagnetic behavior with a critical field of about 8 kOe. The susceptibility behavior of YbAu indicates that about 97% of the Yb is dipositive, the remainder tripositive. Néel points are observed only for the compounds of gold with Gd, Tb, and Ho. They range from 43 for TbAu to 10°K for HoAu. Except at the lowest temperatures, Curie–Weiss behavior is exhibited by all the Au compounds other than YbAu, with effective moments in good agreement with that of the free tripositive lanthanide ion. Deviations from Curie–Weiss behavior at the lowest temperatures in both series are ascribed to crystal field effects. (auth)

3506 APPEARANCE OF A YIELD POINT IN VANADIUM ALLOYS. Boehm, H.; Mir, F. (Kernforschungszentrum, Karlsruhe, Ger.). J. Less-Common Metals, 11: 408-16(Dec. 1966). (In German).

The influence of the Ti content, temperature, and strain rate on the appearance of a yield point in V alloys was studied. In binary V–Ti alloys a yield point is observed at a Ti content of more than 5%. All ternary V–Ti–Nb alloys with 5 to 20% Ti and 20% Nb show a yield point. The kinetics of strain aging can be described in terms of a mechanism proposed by Cottrell and Bilby. The activation energy for strain aging determined by a return-of-yield point method was found to be 23.7 kcal/mole in V–10Ti–20Nb and 21.7 kcal/mole in V–20Ti–20Nb, suggesting oxygen or carbon diffusion. The influence of titanium content on the yield point is discussed. It is shown that the disappearance of the yield point at high temperatures (750 to 850°C) and low strain rates (0.02 to 0.2/min) can be explained on the assumption that the strain rate must exceed the value of $D \times \rho$, where D is the diffusion coefficient and ρ the dislocation density. (auth)

3507 THE THERMAL AND ELECTRICAL CONDUCTIVITIES OF SCANDIUM, YTTRIUM, AND MANGANESE AND TWELVE RARE-EARTH METALS, AT NORMAL TEMPERATURE. Jolliffe, B. W.; Tye, R. P.; Powell, R. W. (National Physical Lab., Teddington, Eng.). J. Less-Common Metals, 11: 388-94(Dec. 1966).

Values for the thermal conductivity and electrical resistivity of lanthanum, cerium, praseodymium, neodymium, samarium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, lutetium, scandium, and yttrium at 18°C are presented, together with a summary of values proposed by earlier workers. A value for the thermal conductivity of manganese is also included. Most previous results have indicated that the electrical conductivities of the rare earth metals are lower than normally expected for pure metals. The present measurements confirm this but show the thermal conductivities to be much greater than the Wiedemann–Franz–Lorenz law would indicate. The unusually large lattice components of thermal conductivity at normal temperatures may amount to up to 43% of the total thermal conductivity. (auth)

3508 METHOD FOR INCREASING THE CRITICAL CURRENT DENSITY OF HARD SUPERCONDUCTING ALLOYS AND THE IMPROVED PRODUCTS THEREOF. Betterton, J. O.; Kneip, G. D.; Easton, D. S.; Scarbrough, J. O. (to U. S. Atomic Energy Commission). U. S. Patent 3,275,480. Sept. 27, 1966.

An invention relating to a hard superconducting alloy having a metallurgical structure comprising a homogeneously distributed precipitated phase containing an additive selected from C, O_2, N_2, B, and H_2 at a concentration which enhances the superconductivity of the alloy relative to the superconductivity at a lesser concentration of the additive is described. (auth)

Structure and Phase Studies

Refer also to abstract 3011.

3509 (DRI-1092-235) STUDIES OF THE EFFECT OF INTERSTITIAL ADDITION ON THE PHASE EQUILIBRIA OF THE NIOBIUM-RICH REGION OF THE NIOBIUM–TUNGSTEN–HAFNIUM AND NIOBIUM–TUNGSTEN–ZIRCONIUM ALLOY SYSTEMS. Quarterly Progress Report No. 8. Yamamoto, Albert S. (Denver Research Inst., Univ. of Denver, Colo.). Sept. 1966. Contract AT(11-1)-1092. 9p. (DRI-2353). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

The effect of small carbon and oxygen additions on the phase equilibria of the niobium-rich region of the niobium–tungsten–hafnium and niobium–tungsten–zirconium alloy systems is under investigation. The features of the niobium-rich isotherms, although not final as yet, are observed as follows: (1) Nb–W–Hf alloys with carbon additions: HfC is at least the principal second phase besides perhaps another precipitate beyond the phase boundary of the Nb-rich Nb–W–Hf solid solution with carbon addition in the range of 0.05 to 0.5 wt %. The solid solution phase fields at both 1600 and 1300°C are much more restricted as a result of carbide precipitation than that determined at 1300°C for similar alloys without intentional carbon additions. (2) Nb–W–Hf alloys with oxygen additions: The region of Nb-rich solid solution is limited by addition of oxygen. Oxygen seems to be more effective in restricting the solid solution than carbon is. In the compositional range investigated, HfO_2 is the precipitated phase in most of alloys containing more than 5 wt % Hf. Other phases appeared to exist in alloys with 15 wt % each and 25 wt % each of tungsten and hafnium and 0.1 wt % O is W_2Hf. (3) Nb–W–Zr alloys with carbon additions: Carbon additions (from 0.01 to 0.25 wt %) to the Nb–W–Zr alloys resulted in the formation of ZrC at both 1600 and 1300°C as a primary precipitate in the Nb-rich solid solution whose solubility range was subsequently reduced further than the comparable solid solution without carbon. Another effect of carbon observed is that it stabilizes α-Zr at these two temperatures as oxygen does to the similar alloys. Existence of W_2Zr is determined in alloys containing 25 wt % each of tungsten and zirconium and 0.01 to 0.25 wt % C. (4) Nb–W–Zr alloys with oxygen additions: No tentative solubility range of the Nb-rich solid solution is established as yet although it is anticipated to be very limited. Like carbon, oxygen when added to these alloys (in the range of 0.01 to 0.1 wt %) produces α-Zr which is stable at both 1600 and 1300°C. In addition to α-Zr, W_2Zr is found to be present in Nb–25 wt % W–25 wt % Zr alloys with 0.01 to 0.1 wt % C. (auth)

3510 STUDY ON COPPER-RICH COPPER–HAFNIUM ALLOYS. Watanabe, Ryoji (National Research Inst. for Metals, Tokyo). Nippon Kinzoku Gakkaishi, 30: 754-9(1966). (In Japanese).

A high-purity Cu Hf alloy was investigated. The Hf content in the alloys varied from 0.08 to 1.73%. The solid solubility of Hf in Cu and some physical and mechanical properties of the alloys were determined. The maximum solid solubility of Hf in Cu is 0.96% at the eutectic temperature of 970°C. The alloys are age-hardenable and during aging the platelets of Cu_7Hf_2 precipitate on {111} habit planes of the matrix alloys. Tensile strengths of 44 to 56 kg/mm² and electrical conductivities of 68 to 70% IACS were obtained for 0.43 to 1.73% Cu–Hf alloys that were solution heat treated, cold worked and aged at 450°C. It is known that Cu–Hf alloys are able to maintain the strength acquired by cold working at temperatures up to 450 to 500°C. (auth)

3511 INVESTIGATION OF THE SYSTEM $TiCr_2$–$TaCr_2$–$NbCr_2$. Budberg, P. B.; Alisova, S. P. Porosh. Met., Akad. Nauk Ukr. SSR, No. 10, 65-70(Oct. 1966). (In Russian).

The methods of x-ray and high-temperature thermal analysis were used to plot the state diagram of the $TiCr_2$–$TaCr_2$ system, which is a section of the ternary system Ti–Ta–Cr. The formation of continuous series of solid solutions is determined between both high- and low-temperature modifications of $TiCr_2$ and $TaCr_2$ compounds. In the $TaCr_2$–$NbCr_2$ system, besides the formation of a continuous series of solid solutions between isomorphous modifications of compounds the formation of a phase with the structure of Fe–W carbide was found at 1350 to 1400°. (auth)

3512 INVESTIGATION OF METASTABLE β ALLOYS OF THE Ti–Mo–Fe–Al SYSTEM. Ageev, N. V.; Glazunov, S. G.; Petrova, L. A.; Tarasenko, G. N.; Grankova, L. P. Izv. Akad. Nauk SSSR, Metal., No. 1, 139-48(Jan.-Feb. 1966). (In Russian).

The Ti–Mo–Fe–Al alloys investigated quench to the β solid solution, i.e., have an electron concentration of more than 4.20 electrons/atom, but contain not more than 8.5% Fe and 8% Mo as well as 2.3 and 4% Al. Ingots of these alloys were melted by using a mixture of titanium sponge, Al–Mo master alloy, pure Al, and armco iron. The ingots, weighing 400 g, were lathe-turned and subsequently hot-forged in an electric furnace at 1000 to 1100°C into rods of 15-mm diameter and squares measuring 15 × 15 mm. The forged alloys were annealed at 750 and 800°C for 1 hr and water quenched. All the alloys quenched from 750°C had the β + α phase structures, and all those quenched from 800°C had the structure of the β solid solution as was to be expected from their electron concentration. The forgings were milled in a milling machine and cut up into specimens for microstructural and radiographic examination as well as for tests of hardness and tensile strength. Measurements of the Vickers hardness of these alloys as a function of aging temperature (200 to 600°C) and time (1 to 100 hr) revealed that for most of the alloys hardness reaches its maximum (~500 kg/mm) after 10 to 25 hr at any aging temperature within the limits considered and thereafter remains virtually constant for 100 hr. Beta alloys containing 2% Al, when heated to 400 to 500°C, undergo decomposition with segregation of ω phase, which is transformed into α phase after 10 hr. Beta alloys containing 3 and 4% Al undergo decomposition with segregation of α phase. Of the alloys of Ti + 7% Mo + 6% Fe + 2, 3, and 4% Al the best mechanical properties (tensile strength 160 kg/mm², plasticity 7.0%) were displayed by the alloy with 3% Al aged at 525°C for 20 hr and subsequently cooled in air. (ATD)

3513 EFFECT OF RARE EARTH METALS ON THE GRAIN SIZE AND FINE STRUCTURE OF STRUCTURAL STEEL. Sandomirskii, M. M.; Zav'yalov, A. S. Izv. Akad. Nauk SSSR, Metal., No. 2, 107-9(Mar.-Apr. 1966). (In Russian).

The effect of cerium, lanthanum, praseodymium, and neodymium (added in amounts of 0.15, 0.30, 0.60, and 1.2%) on the grain size of 35KhN3 and 35KhN3MF steels, on the tendency of the grain to grow during heating, and on the fine structure of the steel was studied. The grain size during heating was determined by the boundary oxidation method; the size of mosaic blocks was determined by x-ray diffraction. The rare earth elements were found to hinder appreciably the growth of austenite grains during heating and to raise markedly the temperature at which a rapid growth of grain begins. These effects increased with rising rare earth content. At moderately high temperatures (800 to 850°C), the rare earths are thought to decrease the degree of disorientation of austenite grains. X-ray data showed that the rare earths decrease the size of mosaic blocks somewhat following quenching, and strongly inhibit the growth of the blocks during heating of the steel. This influence of rare earths is attributed to the inhibition of the process of segregation of carbon from the supersaturated α phase. (ATD)

3514 SELECTIVE SEPARATION OF METALLIC COMPOUNDS FROM MULTICOMPONENT THREE-PHASE ALLOYS. Golubtsova, R. B. Izv. Akad. Nauk SSSR, Metal., No. 1, 136-8 (Jan.-Feb. 1966). (In Russian).

Conditions for the anodic isolation of metallic compounds from two multicomponent alloys having a three-phase structure are discussed. The phase composition of alloy 1 (15.51% Nb, 0.25% Mo, 1.07% Cr, 0.67% W, 5.72% Al, Ni base) was 45% Ni_3Nb, 45% Ni_3Al, and 10% γ1 (solid Ni solution treated with 10% Cr, 6% W, and 3% Mo), and the phase composition of alloy 2 (12.60% Nb, 1.46% Mo, 5.51% Cr, 1.38% Al, Ni base) was 33.75% Ni_3Nb, 11.25% Ni_3Al, and 55% γ4. The electrolytic behavior of these alloys was investigated in the presence of such electrolytes as: (1) 50 cc 57% $HClO_4$, 10 cc HCl (1.19), 35 g of citric acid, 1000 cc CH_3OH; (2) 50 cc HNO_3 (140), 20 cc 57% $HClO_4$, 1000 cc CH_3OH; (3) 50 cc $HClO_4$, 35 g of citric acid, 1000 cc CH_3OH. The activizing effect of the chlorine ion is demonstrated after HCl is added to electrolyte 3, which strongly displaces the potential to the left; this results in curves characteristic of an alloy in an active state. Thus, the phase Ni_3Nb may be selectively isolated in electrolyte 1 despite the presence of another phase, Ni_3Al, in the alloy. The selective isolation of two metallic compounds, the phases Ni_3Nb and Ni_3Al, is due to the considerable potential difference of the investigated alloys, which arises in electrolytes 1 and 2. For anodic isolation of the phase Ni_3Nb the alloy must exist in an active state, which is evidently associated with the nature of this phase, while the anodic polarization of the phase Ni_3Al should occur in the presence of a marked

polarization passivating the surface of the alloy. The potential–time curves plotted for alloy 2 show that its dissolution occurs in the presence of a fixed potential, which sets in rapidly. The experiments with alloy 1 at current densities i = 0.05 and 0.1 A/cm^2 resulted in the anodic isolation of the compound Ni_3Nb with a rhombic crystal lattice. Radiographic and microchemical analyses showed that the anodic dissolution of alloys 1 and 2 resulted in the isolation of the phase Ni_3Nb with a rhombic lattice except for one case (alloy 1, i = 0.15 A/cm^2, electrolyte 2) where the anodic residue was found to be a cubic face-centered lattice representing a Ni_3●-base solid solution in which the phase Ni_3Nb is dissolved. The metallic compounds thus isolated can be used to harden various alloys. (ATD)

3515 X-RAY INVESTIGATION OF THE PART OF THE Al–Be–Ce SYSTEM IN THE 0- TO 25-PERCENT Ce REGION. Zarechnyuk, O. S.; Frankevich, D. P.; Kripyakevich, P. I. Izv. Akad. Nauk SSSR, Metal., No. 1, 153-5(Jan.-Feb. 1966). (In Russian).

Specimens of 34 ternary Al–Be–Ce alloys melted in corundum crucibles (helium atmosphere) within electric resistance furnaces and quenched from 600°C were subjected to x-ray phase analysis in the region of Ce concentrations of from 0 to 25 at. %. Aside from Be itself, only two binary compounds, $CeAl_4$ and $CeBe_{13}$, were found in equilibrium with the Al-base solid solution. In the presence of 20 at. % Ce the ternary compound of variable composition $CeBe_{1.2\to1.4}Al_{2.8\to2.6}$(D phase) forms in the Al–Be–Ce system; this compound exists in an equilibrium with the binary compounds $CeBe_{13}$, $CeAl_4$, and $CeAl_2$ but it does not exist in an equilibrium with the Al-base solid solution. These findings make it possible to compare the Al corner of the Al–Be–Ce system with the corresponding parts of certain other Al–X–Ce systems, namely, systems with Cu, Mn and Si. Thus, ternary intermetallic compounds exist in all these systems but, by contrast with the systems Al–Cu–Ce, Al–Mn–Ce, and Al–Si–Ce, the ternary compound ($CeBe_{1.2\to1.4}Al_{2.8\to2.6}$) forming in the Al–Be–Ce system does not exist in an equilibrium with the Al-base solid solution. On the other hand, the D phase of the Al–Be–Ce system is isostructural with the T_5 phase of the Al–Cu–Ce system. (ATD)

3516 CONSTITUTION DIAGRAM OF THE Mg–Nd–Ni SYSTEM IN THE Mg-RICH REGION. Drits, M. E.; Padezhnova, E. M.; Bochvar, N. R. Izv. Akad. Nauk SSSR, Metal., No. 1, 149-52(Jan.-Feb. 1966). (In Russian).

Alloys of the Mg–Nd–Mn system containing small amounts of Ni display high mechanical properties at elevated temperatures. The elucidation of the role of Ni in strengthening the alloys of Mg with Nd and Mn as yet requires investigating the nature of the interaction between components in ternary (Mg–Nd–Mn, Mg–Nd–Ni, and Mg–Mn–Ni) and quaternary (Mg–Nd–Mn–Ni) systems. A diagram of the crystallization surface for this corner is presented, as based on the findings of thermal and microstructural analyses of Mg–Nd–Ni specimens melted in electric resistance furnaces under a layer of flux (55% LiCl and 45% KCl). The thermal analysis was carried out by plotting the heating and cooling curves with the aid of the FPK-55 thermal analyzer (heating and cooling rates both were ~2°/min). The investigation of the ternary diagram of Mg–Nd–Ni was commenced with two polythermic cross sections for a fixed content of Mg (85 and 80% respectively), and it established that even minute additions of Ni to Mg–Nd alloys lead to the formation of a new ternary compound conditionally denoted as χ. In addition, it was possible to establish the presence of two new nonvariant transformations, peritectic at 468°C and eutectic at 455°C, and to find that the phases Mg_9Nd, χ, and Mg_2Ni are in an equilibrium with the Mg-base ternary solid solution. The plotted projection of the crystallization surfaces of the Mg–Nd–Ni system is such that the lines of the monovariant transformations e_1P and e_2E are drawn from the critical points of the binary system to the corresponding nonvariant points P and E across the compositions of the alloys present on the polythermic cross sections at the points of contact between two-phase fields. (ATD)

3517 PHASE DIAGRAM OF THE NIOBIUM–ANTIMONY SYSTEM. Myzenkova, L. F.; Baron, V. V.; Savitskii, E. M. Izv. Akad. Nauk SSSR, Metal., No. 2, 163-5(Mar.-Apr. 1966). (In Russian).

Microstructural, thermal, and x-ray methods as well as microhardness measurements were used to plot the phase diagram of the Nb–Sb system. Four compounds were identified in this system: Nb_3Sb (75.00 at. % Nb), NbSb (50 at. % Nb), and apparently also Nb_3Sb_2 (60 at. % Nb) and Nb_4Sb_5 (44.4 at. % Nb). All the compounds are formed by peritectic reactions taking place at 1750, 1140, 1020, and 760°C respectively. The microhardness of alloys based on the compound Nb_3Sb amounts to 668 to 490 kg/mm^2, which indicates the presence of a region of solid solution based on this compound; the microhardness of NbSb is 235, and that of Nb_4Sb_5, 357 kg/mm^2. X-ray structural analysis confirmed that the compound Nb_3Sb has a cubic primitive lattice with constant a = 5.26 Å. NbSb has a hexagonal lattice (a = 4.270 Å, c = 5.447 Å, a/c = 1.276) belonging to the NiAs type. Niobium lowers the melting point of antimony, forming with it a eutectic (610°C) whose composition is displaced toward antimony (pseudoeutectic). The phase diagram of the Nb–Sb systems is in many respects analogous to that of elements of group Vb (V, Nb) with elements of group IIIa (Ga). (ATD)

3518 X-RAY-DIFFRACTION STUDY OF ALLOYS OF THE Nb–Fe SYSTEM AND DETERMINATION OF CERTAIN THERMODYNAMIC PROPERTIES OF THE COMPOUND $NbFe_2$. Drobyshev, V. N.; Rezukhina, T. N. Izv. Akad. Nauk SSSR, Metal., No. 2, 156-62(Mar.-Apr. 1966). (In Russian).

Alloys of the Nb–Fe system were studied by x-ray diffraction over a wide concentration range. Their thermodynamic properties were investigated by measuring the emf of a galvanic cell in which the solid electrolyte consisted of solid solutions in the ThO_2–La_2O_3 system, and Fe, $Fe_{0.95}O$ was the reference electrode. The x-ray data confirmed the existence of the two intermediate phases ϵ ($NbFe_2$) and η (Nb_2Fe_3) in the Nb–Fe system. The region of homogeneity of the η phase extends from ~56.0 to 63.0 at. % Nb, and the lattice spacing of the alloy corresponding to the stoichiometric composition Nb_2Fe_3 is 11.24 kX. The region of homogeneity of the phase $NbFe_2$ does not exceed 30 to 37 at. % Nb. The emf measurements at 1280 to 1393°K were used to determine the thermodynamic functions of the compound $NbFe_2$: $\Delta H^\circ_{298} = -4.9$ kcal/g-atom, $\Delta G^\circ_{298} = -4.6$ kcal/g-atom, and $\Delta S^\circ_{298} = -1.1$ cal/deg g-atom. The experimental data are discussed from the standpoint of the electronic structure of the metallic components. (ATD)

3519 INVESTIGATION OF INTERATOMIC INTERACTION IN ALLOYS OF THE NIOBIUM–TUNGSTEN–MOLYBDENUM SYSTEM. Nedyukha, I. M.; Chernyi, V. G. Dopov. Akad. Nauk Ukr. RSR, No. 9, 1166-9(1966). (In Ukrainian).

The moduli of normal elasticity, the characteristic temperature, and the value of the mean-square deviation of atoms from the position of equilibrium in binary and ternary alloys of Nb with W and Mo were determined. The data obtained show an increase of strength of interatomic bonds in the Nb crystal lattice during separate and combined alloying with W and Mo. (auth)

3520 EQUILIBRIUM DIAGRAM OF THE SYSTEM NIOBIUM–NICKEL. Duerden, I. J.; Hume-Rothery, W. (Oxford Univ.). J. Less-Common Metals, 11: 381-7(Dec, 1966).

The equilibrium diagram of the system niobium–nickel was determined by a combination of thermal analysis, microscopical metallography, and x-ray techniques. Nickel is able to dissolve up to 12.5 at. % Nb at high temperatures, while niobium dissolves only 4.5 at. % of Ni. The system contains an intermediate phase (β) Ni_3Nb with the Cu_3Ti type of structure, which gives rise to a maximum on the liquidus curve at 1402°C. There is also a γ phase of composition limits 50 to 54 at. % Nb, formed by a peritectic reaction at 1295°C. (auth)

3521 THE LATTICE SPACINGS OF THORIUM-RICH SOLID SOLUTIONS WITH PRASEODYMIUM, SAMARIUM, GADOLINIUM, AND ERBIUM. Norman, M.; Harris, I. R.; Raynor, G. V. (Univ. of Birmingham, Eng.). J. Less-Common Metals, 11: 395-402(Dec, 1966).

Lattice spacings were determined for the solid solutions of praseodymium, samarium, gadolinium, and erbium in thorium. The results indicate that the solid solubility of praseodymium exceeds 90 at. % at 900°C. Those of samarium and erbium lie between 50 and 60 at. % (900°C). Gadolinium is soluble to approximately 60 at. % at 900°C. Extrapolation to 100 at. % solute of the curves of lattice spacing and atomic volume against composition allows values to be derived for the apparent atomic diameters and atomic volumes of the rare earth metals in hypothetical face-centered cubic forms. Except for erbium, the apparent atomic volumes in the face-centered cubic forms are less than for the pure elements; that for erbium slightly exceeds the value for the element. The results are discussed with special reference to the crystal structures of the elements, and to the effect of magnetic interactions on the apparent atomic size of gadolinium. (auth)

Radiation Effects

Refer also to abstracts 3483 and 3934.

3522 (N-66-29447) A STUDY OF THE BLISTERING OF METAL SURFACES BY SOLAR SYSTEM IONS. Quarterly Progress Report No. 1 [for] Period Ending July 14, 1965. Cooley,

J. A. (Avco Corp., Tulsa, Okla.). Aug. 1965. Contract NASw-1203. 10p. (NASA-CR-67132). CFSTI $3.00 cy, $0.65 mn.

Single crystal samples of pure Al were irradiated in vacuum with 30-, 50-, and 70-keV protons at various total fluxes. The objective was to define optimum parameters for oxide film removal with no residual blistering of the surface. Results were not consistent thus indicating probable variation of oxide layer thickness. Two pure polycrystalline Au samples were irradiated one with 15-keV protons and one with 100-keV protons. No surface blistering was noted on these samples. (auth)

3523 INFLUENCE OF α RADIATION ON SELF-DIFFUSION IN LEAD. Frenzel, D. (Univ., Gottingen, Ger.). Z. Phys. Chem. (Frankfurt), 51: 67-83(Oct. 1966). (In German).

By the method of absorption of α backscattering, using ^{212}Pb, the self-diffusion in lead was followed. Single crystals as well as cast and cut samples were used. The effects of α particles from an external ^{210}Po source were observed as an increase in the diffusion coefficient during the irradiation period. The diffusion in single crystals can be expressed as $D = 1.1 \times 10^2 \exp(-22100/RT)$ cm^2. sec^{-1} and that in polycrystalline material by $D = 2.2 \times 10^7 \exp(-15100/RT)$ cm$^2 \cdot$ sec^{-1}. The apparent activation energy for self-diffusion up to 40°C is about 7000 cal/mol. In this temperature region the diffusion coefficient appears to be independent of temperature. (tr-auth)

3524 INFLUENCE OF α RADIATION ON THE SURFACES OF LEAD SINGLE CRYSTALS. Frenzel, D. (Univ., Gottingen, Ger.). Z. Phys. Chem. (Frankfurt), 51: 58-66(Oct. 1966). (In German).

Lead single crystals were irradiated with α particles. In electron microscopic comparisons of irradiated and unirradiated crystals, changes in the surface were observed. To explain this effect a surface diffusion mechanism is presented. (tr-auth)

3525 COMPARISON OF ELECTRON-RADIATION DAMAGE THRESHOLDS OF SILVER AT LIQUID-HELIUM AND LIQUID-NITROGEN TEMPERATURES. Roberts, C. Gordon; Rickey, W. P.; Shearin, Paul E. (Univ. of North Carolina, Chapel Hill). J. Appl. Phys., 37: 4517-18(Nov. 1966). (ORO-2577-16).

The threshold for electron-radiation damage in silver at liquid-helium and liquid-nitrogen temperatures was found to be the same to better than 1 eV. (auth)

3526 EFFECT OF NEUTRON IRRADIATION ON THE MECHANICAL PROPERTIES OF IRON. Maeng, Sun-chae (Seoul National Univ.). New Phys. (Korea), 6: No. 1, 1-3(May 1966). (In Korean).

Mechanical properties of irradiated armco iron were compared with unirradiated specimens after the irradiation of integral total flux of 4×10^{18} n/cm^2 ((fast neutrons: 1.4×10^{18} n/cm^2; thermal neutrons: 2.6×10^{18} n/cm^2). After the irradiation yield strength $\sigma_{0.2}$ was increased but tensile strength σ_B was not changed. Also percentage elongation was decreased about 10% and $(\sigma_B - \sigma_{0.2})/\sigma_B$ was decreased. (auth)

3527 INVESTIGATION OF THE WEAKENING EFFECT DUE TO ANNEALING IN NEUTRON-IRRADIATED SINGLE CRYSTALS OF Al, Cu, AND Mo. Borimskaya, S. T.; Larikov, L. N.; Plotnikova, N. P. (Inst. of Metal Physics, Academy of Sciences, Ukrainian SSR). Fiz. Metal. Metalloved., 21: 797-9 (May 1966). (In Russian).

The effect of annealing on the strength of neutron-irradiated single crystals of Al, Cu, and Mo was studied. The strength of the single crystals was assessed by means of microhardness measurements. The structural changes occurring during annealing were studied by x-ray techniques. The experimental results, presented graphically, show that none of the irradiated single crystals investigated undergoes recrystallization. It is concluded that the strengthening effect of neutron irradiation on the single crystals of Al, Cu, and Mo is not due to a recrystallization process. (ATD)

3528 EFFECTS OF HEAT TREATMENT AND NEUTRON IRRADIATION ON THE MAGNETIZATION CURVE OF COBALT. Klugmann, E. (High School of Pedagogy, Danzig). Acta Phys. Pol., 30: 381-91(Sept. 1966).

The elementary magnetization process defining the reversible susceptibility of polycrystalline cobalt are discussed on the basis of temperature-dependence measurements. In the unannealed specimen there is no first maximum of susceptibility which appears at a temperature of +290°C in cobalt annealed in a hydrogen atmosphere. The isotherms $\chi_{rev}^{-1} = f(H)$ are a linear dependence within a broad range of fields. It was found that temperature affects the Gans curves. Irradiation with a 0.8×10^{18} cm^{-2} dose of fast neutrons brings about permanent radiation defects which cause a drop in the initial susceptibility of cobalt by 2.5% and an increase in coercive force by 15%. (auth)

Ceramics and Cermets

Refer also to abstract 3458.

3529 (EURAEC-1476) PHYSICAL PROPERTIES OF UO_2 SINGLE CRYSTALS. Quarterly Report No. 13, April 1-June 30, 1965. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). 32p. (EUR-2397). Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Work Performed Under United States-Euratom Joint Research and Development Program.

The preparation of large single crystals using large sintered cylinders made by slip casting has been successful. Their oxidation to U_{2+x}/U_4O_9 can be achieved without difficulty. The effect of irradiation on the behavior of U_4O_9 precipitates after various doses has been studied by observations in the optical microscope. New experimental results of U self-diffusion have been obtained at 1465° and 1800°C. The U self-diffusion coefficients measured up to now are in agreement with those reported by Auskern and Belle. Electron microscopic observations made on U_4O_{9-y} crystals suggest the existence of antiphase boundaries (similar as observed in small U_4O_9 precipitates). The electron diffraction patterns of small U_4O_9 precipitates in UO_2 and those of the U_4O_{9-y} crystals show the same superlattice structure. A completely reduced UO_2 crystal, the thermal conductivity of which was determined before, has been slightly oxidized ($x < 0.001$) and remeasured in the temperature range 4 to 300°K. Hall effect measurements have been performed on crystals of different O/U ratio from 20 to 400°C. A change from n- to p-type conduction has been observed for crystals with O/U between 2.001 and 2.12. New measurements of the thermoelectric power of reduced crystals have been made. When plotted against the reverse temperature the thermoelectric power curves exhibit a linear behavior, the associated activation energy lying between 0.06 and 0.10 eV. Measurements after reactor irradiation are in progress. Some remarks about the temperature dependence of the thermoelectric power in UO_2 are given. The relaxation effects have been the subject of further investigations. Different heat treatments were tried in order to try and obtain a correlation between the peak heights and the thermal history of the specimen. (auth)

Corrosion and Erosion

3530 (GA-tr-6049) KINETIC STUDIES OF THE OXIDATION OF GRAPHITIZABLE CARBONS BY LIQUID MEDIA. Oberlin, M.; Mering, J. (Institut National de Recherche Chemique Appliquee, Paris (France)). Translated by A. S. Schwartz and J. L. White (General Dynamics Corp., San Diego, Calif. General Atomic Div.), from paper Presented at the Sixth Conference on Carbon, Pittsburgh, Pa., June 17-21, 1963. 26p. (CONF-73-26). Dep. mn. JCL $2.60 fs, $0.98 mf.

All carbons are oxidized to CO_2 in a hot mixture of H_2SO_4 and $Ag_2Cr_2O_7$. A study of the kinetics of the reaction showed that the rate of oxidation varies by 1000 fold, depending on the state of graphitization. The smallest reaction rate constant, k_1, was observed with soft carbons heat treated between 1000 and 1200°C. The highest reaction rate constant, k_3'', was observed with natural graphite or with artificial graphite with a degree of graphitization approaching unity. In a partially graphitized carbon (heat treated between 1500 and 2800°C), four rate constants, k_1, k_2, k_3' k_3'', were involved in simultaneous reactions, the two extremes of which were identified above. True measurements of the kinetics of oxidation permitted detection of the presence of four structural constituents, F_1, F_2, F_3', and F_3'', and the estimate of their relative proportions. Each constituent corresponds to a particular structural state of the elementary carbon layers. Results of kinetic analysis are discussed in relation to the physical properties and measurements of x-ray diffraction. (auth)

3531 METHOD OF CLADDING YTTRIUM HYDRIDE AND YTTRIUM BASE ALLOY HYDRIDES. Bohlander, K. M.; Funston, E. S.; McGurty, J. A. (to U. S. Atomic Energy Commission). U. S. Patent 3,277,565. Oct. 11, 1966.

An invention relating to a method of preparing a clad hydride body is described. A layer of metallic Cr at a thickness of 0.001 in. to 0.010 in. is applied to a body consisting of a metal selected from a group of Y and Y-base alloys. The Cr-coated body is heated at 2000 to 2260°F in a non-oxidizing atmosphere allowing the Cr to bond. The bonded metal body and the resulting Cr-coated hydride body are thus clad with an oxidation-resistant metal. (auth)

Preparation and Fabrication

Refer also to abstracts 3160 and 3552.

3532 (N-66-29910) IDENTIFYING OPTIMUM PARAMETERS OF HOT EXTRUSTIONS. Interim Report No. II. Rice, Roy W. (Boeing Co., Seattle, Wash. Aerospace Group); Hunt, James G. (Nuclear Metals, Inc., Concord, Mass.). May 3, 1966. Contract NAS7-276. 105p. (NASA-CR-76057). CFSTI $3.00 cy, $0.65 mn.

A program to develop a technique for hot extruding MgO and to determine the effect of hot extrusion on MgO is described. Preliminary evaluations of the effects of extrusion will be made on other oxide bodies. Crack free MgO extrusions were obtained from 1-in.-dia billets in a 1-in-thick-wall W can, while extrusion of 1.5-in.-dia billets in a 0.75-in-thick-wall can were cracked. Extrusion into a catch tube heated to 2000°C reduced, but did not eliminate cracking. The mechanism of cracking appears to be either excessive shear or thermal stress of the ceramic, with the latter favored. Testing of extruded MgO showed that its strength is 50%, or more, greater than hot-pressed MgO of equivalent grain size. The increase in strength was shown to be due to decreased misorientation of grains by the (100) axial texturing. The extruded material obeyed the Petch relationship. Fracture texture of the extruded MgO allowed fracture origins to be detected, which, along with strength analysis, showed that crack nucleation by dislocation pile-up at grain boundaries occurs in extruded MgO, and is probably the controlling factor in the strength of all dense MgO of adequate purity and flaw content. Extruded bodies, especially those without cracks, were found to have residual stresses. This apparently was the cause of weakening of the bodies by chemical polishing. Annealing for 1 hr at 2200°F relieved these stresses. (auth)

3533 (TRG-Report-1261) THE EFFECT OF MILLING UPON THE MICROSTRUCTURE OF URANIUM DIOXIDE POWDER. Ferguson, I. F. (United Kingdom Atomic Energy Authority, Springfields (England). Reactor Group). Jan. 1962. Reprinted 1966. 22p. Dep. BIS $0.90, HMSO 4s. 6d.

The effect of milling a uranium dioxide powder has been examined by x-ray line broadening studies, B.E.T. surface area measurements, and electron microscopy. It is shown that milling breaks down the agglomerates, particles, and crystallites in the powder and regularizes the shape of the latter. The initial milling decreases crystal lattice strain. It is believed that this strain is associated with the irregular "necked" shape of the crystallites. Further milling in air causes a steady increase in the strain. It is believed that this increase is associated with the progressive contamination of the powder with α-U_3O_7 which is caused by oxidation. (auth)

3534 STUDY ON CEMENTS SYSTEMS UO_2–MgO AND UO_2–CaO. Amato, I. (FIAT, Turin). Met. Ital., 58: 365-8 (Sept. 1966). (In Italian).

Cermets belonging to UO_2/MgO and UO_2/CaO systems were examined. The thermodifferential analysis disclosed the existence of reaction peaks above 1100°C, ascribed to the formation of solutions or new compounds. Sintered products were micrographically examined and in both cases the building up of a liquid phase beginning at 1400°C was shown. Sintered densities were very high, but the hygroscopicity does not allow the use of such materials as nuclear fuels. (auth)

3535 PREPARATION OF THIN-WALLED THORIUM-OXIDE CERAMIC BODIES OF HIGH DENSITY BY SLIPCASTING. Ullmann, Helmut; Naumann, Dieter; Burk, Werner (Central Inst. for Nuclear Research, German Academy of Sciences, Rossendorf, Ger.). Silikat Tech., 17: 209-11(July 1966). (In German).

The optimum manufacturing parameters for the preparation of ceramic bodies from ThO_2 with thin walls and high sintering density were determined. The relationships required for determination of these conditions were obtained from reports published in the literature. Slip-casting was the preferred technique; the results of tests involving various sintering temperatures and conditions were described. Sintering at 2100°C provided bodies with a wall thickness of 0.6 mm., having almost the theoretical maximum density. These bodies could be used in vacuum-tight systems (20 references). (JPRS)

3536 DEPENDENCE OF GRAIN $NbC_{0.80}$ SIZE ON TEMPERATURE. Ordanyan, S. S.; Avgustinik, A. I. Porosh. Met., Akad. Nauk Ukr. SSR, No. 9, 50-4(Sept. 1966). (In Russian).

The temperature dependence of the grain size of nonstoichiometric niobium carbide $NbC_{0.80}$ was studied in the range of temperatures of 1600 to 3300°K. The energy of grain growth activation is equal to 65.0 kcal/mole; the value of this energy makes it possible to consider that this process is controlled by boundary and surface diffusion. (auth)

3537 INVESTIGATION OF THE CONDITIONS OF ALLOY PREPARATION IN THE SYSTEM YB_6–LaB_6. Bondarenko, V. P.; Bilyk, I. I.; Shlyuko, V. Ya. Porosh. Met., Akad. Nauk Ukr. SSR, No. 9, 43-9(Sept. 1966). (In Russian).

The effects of temperature and duration of sintering on the process of alloy formation in the system YB_6–LaB_6 during combined reduction of oxides by boron in vacuum were investigated. It was found that preparation of homogeneous solid solutions of hexaborides is possible with the presence in the charge of the respective metal instead of one of the oxides. A presumption is advanced that the main accelerating factor is the formation of close contact between the hexaboride particles owing to their joint crystallization one on the other. (auth)

3538 INVESTIGATION OF THE SINTERING OF ALLOYS OF ZIRCONIUM DIBORIDE WITH MOLYBDENUM DISILICIDE. Kuzenkova, M. A.; Kislyi, P. S. Porosh. Met., Akad. Nauk Ukr. SSR, No. 9, 11-16(Sept. 1966). (In Russian).

The process of sintering zirconium diboride with molybdenum disilicide was investigated. X-ray, microstructural, and chemical analyses were used. It is shown that at a temperature above 1800°C shrinkage is due to the appearance of the liquid phase, which disappears during the sintering process. At temperatures up to 1800° an increase in the dimensions of the samples takes place because of heterodiffusion processes with components having various partial diffusion coefficients and the evaporation of surplus silicon for an alloy with 15% $MoSi_2$. (auth)

3539 PREPARATION OF THORIA SOLS BY ELECTRODIALYSIS. O'Connor, Thomas L.; Juda, Walter; McNally, Paul H.; Rosenberg, Norman W. (to Diamond Alkali Co.). U. S. Patent 3,280,011. Oct. 18, 1966. Filed June 19, 1958.

A method is described for preparing fluid aqueous hydrated actinide sols for use in nuclear transmutation and as fuels for homogeneous nuclear reactors. The final product is neutral and comprises particles in a critical concentration. The hydrated actinide oxide of controlled particle-size and particle-uniformity is produced in an aqueous system by separating the actinide and the solubilizing ions from each other in a solution of an actinide compound in heavy or light water, preferably by removing the solubilizing ions. Good uniformity of the final sol is preferably obtained from an appropriate dispersion of seed nuclei. The preparation of thoria sols is given as an example of the method. (P.C.H.)

3540 CERMET MATERIALS AND PROCESS OF MAKING. Brite, Daniel W.; Sump, Kenneth R. (to U. S. Atomic Energy Commission). U. S. Patent 3,276,867. Oct. 4, 1966.

A patent is described relating to a process for making a cermet-type composition of matter by mixing metallic particles of 1 to 50 μ dia with ceramic particles of 75 to 200 μ dia, heating the mixture at 1100 to 1250°C, and compacting the heated mixture. (auth)

3541 METHOD FOR FORMULATING MASTER ALLOY COMPOSITIONS FOR USE IN DISPERSION HARDENED COMPACTS. Hammond, J. P.; Sinka, Krishna K. (to U. S. Atomic Energy Commission). U. S. Patent 3,271,142. Sept. 6, 1966.

An invention relating to a process for producing a compact containing a refractory metal oxide uniformly dispersed within a matrix of a metal or alloy is described. A colloidal-like dispersion of a water-soluble compound of W, Mo, or Re is mixed with a colloidal dispersion of a refractory metal oxide which is stable and non-reactive with these metals at any temperature up to about 2500°C. The liquid phase is separated and a solid dispersion of the metal oxide and metal compound is formed selectively reducing the metal compounds to elemental metal. The resultant oxide-metal powder is then compacted to a densified structure. (auth)

3542 FLUIDIZATION OF SINTERABLE FINES. Gabor, John D.; Baerns, Manfred (to U. S. Atomic Energy Commission). U. S. Patent 3,273,974. Sept. 20, 1966.

A patent relating to a method for fluidizing and reacting sinterable fines is described. The fines are mixed with larger inert particles to form a bed and fluidized with an inert gas to create a zone of agitation in the upper portion of the bed while introducing reaction gas into this portion of the bed. (auth)

Properties Evaluations

Refer also to abstracts 3031, 3033, and 3927.

3543 (AERE-R-3994) PERMEABILITY OF NUCLEAR GRADE GRAPHITE TO A VARIETY OF GASES. Hewitt, G. F.; Moore, M. J. C.; Sharratt, E. W. (Atomic Energy Research Establishment, Harwell (England)). Sept. 1966. 24p. Dep. BIS $0.60, HMSO 3s.

An apparatus is described for measurement of gas permeability of nuclear grade graphite; this apparatus was used to measure the

permeability of several specimens to a variety of gases (Ar, He, H_2, O_2, N_2). The permeability coefficients (B_0 the viscous permeability, and K_0 the slip flow coefficient) were found to be similar for all the gases for any particular specimen, but the differences are significant compared to the experimental error. (auth)

3544 (N-66-29388) SOME HIGH TEMPERATURE DIFFUSION STUDIES ON MATERIALS OF THERMIONIC INTEREST. Yang, Ling; Hudson, R. G.; Carpenter, F. D. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). June 28, 1965. Contract NAS3-6471. 15p. (NASA-CR-64768; GA-6472). CFSTI $3.00 cy, $0.65 mn.

Studies were made on the diffusion between a number of U-containing materials and various refractory metals and alloys At 1400 to 2000°C. Results are presented on the nature of interaction at the interfaces of these diffusion couples and the effect of composition, stoichiometry, and temperature on the stability of vacuum electron emission properties of W-clad UO_2 and UC-ZrC. (auth)

3545 THERMODYNAMIC PROPERTIES OF RUBIDIUM-GRAPHITE LAMELLAR COMPOUNDS. Salzano, F. J.; Aronson, S. (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys., 45: 4551-5(Dec. 15, 1966). (BNL-10443).

Phase equilibria in the rubidium-graphite system were studied by means of the Knudsen effusion method in conjunction with a tracer technique. A new compound, $C_{10}Rb$, analogous to the compound $C_{10}Cs$, was observed. Vapor-pressure measurements were made in the various two-phase regions in the rubidium-graphite system at temperatures from 350° to 750°C. Thermodynamic properties were calculated from the data and are compared to the corresponding values in the cesium-graphite system. (auth)

3546 CATION SELF-DIFFUSION AND ELECTRICAL CONDUCTIVITY IN POLYCRYSTALLINE BERYLLIUM OXIDE. de Bruin, H. J.; Watson, G. M.; Blood, C. M. (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 37: 4543-9(Nov. 1966). (ORNL-P-1932).

Beryllium self-diffusion coefficients were determined in high-density polycrystalline BeO in the temperature range 800 to 1795°C. A precision lapping method using Be as a radiotracer was used in the interval above 1180°C, and electrical conductivity was used between 800 and 1250°C. Volume diffusion coefficients determined by both methods correlate well between 1100 and 1250°C. The results can be expressed over the temperature range 1100 to 1800°C by the relation $D = 3.2 \times 10^{-3} \exp(-63.0 \times 10^3/RT)$. Above 1100°C, the agreement between the results obtained by the two techniques supports an ionic drift mechanism for the electrical conductivity of BeO. Below this temperature, however, the transport behavior appears to be considerably influenced by the history of the sample as well as the nature and concentrations of impurities. Classical volume diffusion was observed in a region near the surface of the specimens; at greater depths, deviations occurred and the magnitude of the deviations increased with decreasing grain size of the BeO. These discrepancies were explained on the basis of a simultaneous grain-boundary diffusion mechanism. (auth)

3547 DETERMINATION OF SELF-DIFFUSION COEFFICIENTS BY ALPHA SPECTROMETRY. Marin, J. F.; Coniglio, M. (Centre d'Etudes Nucleaires, Grenoble, France). Nucl. Instrum. Methods, 42: 302-4(July 1966). (In French).

For the quantitative determination of diffusion coefficients the statistical fluctuation of the energy loss after crossing a thickness of given material must be considered. This makes it impossible to establish an unequivocal relation between the residual energy and depth of emission, that is, a direct correspondence between the spectrum and density profile of an active element. The profile spectra obtained from a thin layer of uranium dioxide enriched in uranium-235 and the determination of the diffusion coefficients by a comparison of the slopes of the experimental and calculated profile spectra are shown. (J.F.P.)

3548 THE INFLUENCE OF BINDER PHASE COMPOSITION ON THE PROPERTIES OF WC-Co CEMENTED CARBIDES. Suzuki, Hisashi; Kubota, Haruo (Tokyo Univ. Sumitomo Electric Industries Ltd., Itami, Japan). Planseeber. Pulvermet., 14: 96-109(Aug. 1966).

The relation between the properties of cemented carbides and the composition of the binder phase (cobalt phase) was studied in detail in the range and near the range where no eta phase and no free carbon phase appeared, using mainly WC-10% Co cemented carbides. It was found that the dissolved tungsten content in the binder phase changes sharply from a minimum 2 to 3% (in the high-carbon two-phase alloy) to a maximum 9 to 10% (in the low-carbon two-phase alloy) because of a slight change of the carbon content of the alloy even in the range of two-phase (WC and Co phase), and corresponding to this change various properties of the alloy change remarkably. Transverse-rupture strength, hardness, specific gravity, electrical resistivity, saturation magnetization, and lattice parameter of the binder phase were studied in relation to the change. The effect of annealing the sintered alloy at rather low temperatures (about 800°C) was studied. The high-carbon alloy was approximately stable, but in the low-carbon alloys a change in properties such as strength, electrical resistivity, and others was observed. The reason for such property changes is the precipitation of tungsten contained in the cobalt phase, according to the reaction γ (fcc) $\rightarrow \gamma$ (fcc) + Co_3W. For example the binder phase is precipitation-hardened by the precipitation of Co_3W and it caused a decrease in the strength of the alloy. The precipitation takes place along the (001) crystallographic plane of γ (fcc). (auth)

3549 STRUCTURE AND PHYSICAL AND MECHANICAL PROPERTIES OF WC-TaC-Co HARD ALLOYS. Panov, V. S.; Meerson, G. A.; Funke, V. F. Izv. Akad. Nauk SSSR, Metal., No. 2, 120-4(Mar.-Apr. 1966). (In Russian).

The effect of composition, structure, and temperature on the bend strength, impact toughness, and hardness of a variety of WC-TaC-Co sintered carbides used in cutting tools for machining heat-resistant and other hard and tough materials was investigated. It was found that alloys containing 2 to 90 mole % TaC (in respect to total WC + TaC) have a three-phase structure (WC, TaC, and Co), while those containing over 90 mole % TaC have a two-phase structure (TaC and Co). Additions of 2 to 5 mole % TaC increase considerably the hardness of sintered carbides to 20°C and the bending strength at 800°C, while the impact toughness and bend strength at 20°C remain about the same or decrease very slightly. However, a further increase in TaC content greatly lowers the bend strength of all sintered-carbide specimens. An increase in cobalt content improves the bend strength at both 20°C and 800°C. It reaches a maximum at 800°C with 12 to 16 wt % cobalt, and at 20°C with 20 wt % cobalt. The following optimal composition of WC-TaC-Co sintered carbide is recommended for machining hard and tough metals and alloys: 2 to 5 mole % TaC (re total WC + TaC) and 6 to 12 wt % cobalt, depending on the machining conditions and the material to be machined. (ATD)

3550 RADIATING POWER OF MOLYBDENUM DISILICIDE COATINGS. Zhorov, G. A.; Sivakova, E. V. Teplofiz. Vysok. Temp., 4: 182-8(Mar.-Apr. 1966). (In Russian).

The degrees of total radiation blackness and spectral blackness at .65-μ wavelength of $MoSi_2$ coatings and of Cr-Al-Si coated with $MoSi_2$ alloyed with Al and Cr were investigated. It was found that alloying $MoSi_2$ with Cr and Al increases the coating thermal stability and increases its radiating power. The upper limit for blackness stability is extended to 1700°K by stabilizing the protective surfaces using layers of the alloying elements. (J.R.D.)

3551 ELECTROPHYSICAL PROPERTIES OF NIOBIUM AND ZIRCONIUM CARBIDES IN THEIR HOMOGENEOUS STATES. Samsonov, G. V.; Panasyuk, A. D. (Inst. of Problems in Material Studies, Academy of Sciences, Ukrainian SSR). Teplofiz. Vysok. Temp., 4: 207-13(Mar.-Apr. 1966). (In Russian).

Studies of thermoelectrical properties of Nb and Zr carbides in homogeneous phases showed the relation between electric conductivity and the composition of various carbides of the IV and V groups of the periodic table. Temperature dependence of the thermal emf and specific electric resistance of Nb and Zr carbides, and effects of high-temperature annealing on the electrical properties of these materials were studied. (R.J.V.)

Structure and Phase Studies

Refer also to abstract 3533.

3552 PEROVSKITE CARBIDES WITH RARE EARTH METALS. Haschke, H.; Nowotny, H.; Benesovsky, F. (Univ., Vienna). Monatsh. Chem., 97: 716-7(1966). (In German).

Several new phases with the Cu_3Au or the perovskite carbide structure are reported. Their structures are confirmed by debyeograms. Composition, temperature and length of time of preparation by glowing in quartz vessels, and the cell parameter a in Å for each compound is given as follows: La_3In, 1000°C, 50 hr, 5.11; Pr_3In, - , - , 4.93; Pr_3Tl, 850°C, 210 hr, 5.01; Pr_3Sn, 850°C, 210 hr, 4.99; $La_3InC_{0.7}$, 1000°C, 50 hr, 5.14; Pr_3InC, 850°C, 180 hr, 5.09; Pr_3TlC, 850°C, 180 hr, 5.08; Pr_3SnC, 850°C, 180 hr, 5.06; Pr_3PbC, 850°C, 180 hr, 5.07; Dy_3GaC, 850°C, 180 hr, 5.07; Dy_3TlC, 820°C, 170 hr, 4.88. Other similar structures occur in the systems Pr-Ga-C, Dy-In-C, Dy-Sn-C, and Dy-Pb-C, but the samples were not prepared in homogeneous enough form for satisfactory study. (BBB)

3553 MICROHARDNESS ANISOTROPY, SLIP, AND TWINNING IN Mo_2C SINGLE CRYSTALS. Vahldiek, F. W.; Mersol, S. A.; Lynch, C. T. (Air Force Materials Lab., Wright-Patterson AFB, Ohio). Trans. Met. Soc. AIME, 236: 1490-6(Oct. 1966).

The room-temperature microhardness of as-grown and annealed Mo_2C single crystals was measured on the (0001), $\{2\bar{1}\bar{1}0\}$, and $\{10\bar{1}2\}$ planes using Knoop and Vickers indenters at loads of 25 to 1000 g. The orientation dependence of hardness with respect to crystal axes was also studied. The average random hardness of as-grown crystals was determined to be 1520 kg per mm^2. Annealing to 2000°C decreased the average hardness by 150 units. An increase in hardness after annealing at 2200°C was noted. Optical and electron microscopy revealed slip and twin traces on all planes studied, as produced by microhardness indentations. Basal $(0001)\langle 2\bar{1}\bar{1}0\rangle$ slip was determined to be the primary slip system and was substantiated by electron transmission microscopy. A secondary $\{10\bar{1}0\}\langle 2\bar{1}\bar{1}0\rangle$ slip was produced by microhardness indentations. The latter also produced twinning of the $\{10\bar{1}2\}[0001]$ type, as proven by electron diffraction. Electrical resistivity and elastic-modulus anisotropy were found and correlated with hardness anisotropy and Mo_2C crystal structure. Elastic-modulus values were obtained by microhardness and ultrasonic methods. Bonding mechanism of Mo_2C is discussed. (auth)

3554 DISLOCATION ETCH PITS IN SINGLE-CRYSTAL AND POLYCRYSTALLINE BERYLLIUM OXIDE. Vandervoort, R. R.; Barmore, W. L. (Univ. of California, Livermore). J. Appl. Phys., 37: 4483-6(Nov. 1966). (UCRL-14765).

An etching solution is reported, which can successfully reveal dislocation sites on the basal, first- and second-order prismatic, and the first-order pyramidal planes of beryllium oxide single crystals. Each of these crystallographic surfaces has a uniquely shaped dislocation etch pit not previously reported. Freshly introduced dislocations on all the above planes were mobile at room temperature under high stresses. Dislocation motion was observed in several directions having low indices. The etchant also revealed dislocation sites in as-sintered and plastically deformed polycrystalline specimens. (auth)

3555 CRYSTAL FIELD STUDIES ON VANADIUM AND CHROMIUM IN ZIRCONIUM OXIDE. Meehan, John; Salomon, R. E. (Temple Univ., Philadelphia). Contract AT(30-1)-2775. J. Phys. Chem., 70: 3642-6(Nov. 1966).

Zirconium oxide was used as a host lattice for chromium and vanadium. Optical and paramagnetic resonance spectra of the solid solutions were interpreted by means of ligand field theory. For Cr^{3+} in ZrO_2 Dq = 1627 cm^{-1}, B = 640 cm^{-1}, and $\beta = 0.70$. Both chromium and vanadium were present in two oxidation states in the ZrO_2 lattice. (auth)

Radiation Effects

Refer also to abstract 4412.

3556 (AD-641725) OPTICAL STUDIES OF RADIATION DAMAGE PROCESSES. Final Scientific Report, March 25, 1963-March 24, 1966. Compton, D. M. J. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Apr. 24, 1966. 127p. (AFCRL-66-427). CFSTI $3.00 cy, $0.65 mn.

This program used the high dose rate available from an electron linear accelerator to study radiation damage and excitation-de-excitation processes on a fast time scale. Fast optical techniques were used to study the processes occurring, and apparatus and methods were developed for measuring optical absorption and emission at nanosecond speeds. Progress was also made towards the application of high-speed electron spin resonance to these problems. These techniques were applied to a study of de-excitation, from the energy deposited by an electron pulse in ruby and in GaAs, and also to the kinetics of radiation damage in GaAs. In the alkali halides, absorption techniques were used to study the introduction and annealing of F centers, and the trapping of radiation produced electrons to form F centers. Fast optical techniques proved to give an important increase in the understanding of these processes, and are also useful in understanding radiation-induced conductivity in insulators. Optical absorption and photoconductivity measurements were made to study the kinetics of complex defect center formation in silicon: this work is still in a preliminary stage. (auth)

3557 (TRG-Report-1279) THE EFFECT OF A TENSILE RESTRAINT ON GRAPHITE SPECIMENS IRRADIATED IN BR-2. Brocklehurst, J. E.; McFarlane, A. A.; Gray, B. S. (United Kingdom Atomic Energy Authority, Culcheth (England). Reactor Group). June 29, 1966. 24p. (JNPC-MWP(GSG)/P(66)69).

Specimens of near-isotropic graphites, in the form of rings restrained from shrinking at the inner bore by a mandrel have been irradiated in BR-2, at about 400°C. The net specimen strain rate depended on the rate of irradiation-induced shrinkage and the temperature changes during each reactor cycle. It is shown that at least 0.6% plastic strain may be absorbed in tension without cracking, even when strain is applied for part of the time at rates 2 to 3 times the normal shrinkage rate. The strength of such specimens is not reduced below the unirradiated value by the presence of creep strain. Temperature transients due to operational difficulties caused the development of radial cracks in some specimens, of which a few failed completely. Thus tensile failure appears to be preceded by the development of such fine cracks. (auth)

3558 RADIATION RESISTANCE BY FLUORIDES OF ALKALINE EARTH METALS. Zavadovskaya, E. K.; Blaunshtein, I. M.; Timoshenko, N. M. (Tomsk Polytechnic Inst., USSR). Izv. Akad. Nauk Uz. SSR, Ser. Fiz.-Mat. Nauk, No. 4, 46-9(1966). (In Russian).

An investigation was made of the energy absorbed and stored by CaF_2, SrF_2, and BaF_2 irradiated with gamma rays. The absorbed energy can be spent on luminescence and radiolysis due to irradiation. Since at equal radiation doses the amount of energy stored in CaF_2 is greater than in BaF_2, it can be assumed that the former spends less energy on radiolysis and, consequently, accumulates fewer radiolysis products. The process of radiolysis was investigated on the basis of the absorption and desorption of gases during irradiation and annealing. The most intensive absorption of gas by CaF_2 occurred at doses up to 20 million roentgens; saturation was reached at larger doses. The absorption in SrF_2 was similar. The irradiation of BaF_2 was followed by gas desorption. The greatest desorption in BaF_2 was at doses of the order of 40 million roentgens. During thermal annealing of CaF_2 an induction period was followed by gas desorption at 124°C; further heating led to gas absorption at 223°C and intensive gas desorption at 360°C. An induction period in SrF_2 was followed by gas desorption at 100 to 120°C, partial restoration of vacuum at 200 to 225°C, and intensive gas desorption at 276°C. During the annealing of BaF_2 the gas desorbed intensively at 180 to 200°C. The quantity of desorbed gas after the annealing of an irradiated material depends on the chemical composition of the material. With a decrease in the lattice binding energy and an increase in the cation radius, the quantity of gas desorbed during annealing increases and the temperature of intensive gas desorption decreases. (ATD)

3559 SOME FEATURES OF RADIATIVE CENTERS IN SYNTHETIC QUARTZ ACTIVATED WITH GERMANIUM. Vakhidov, Sh.; Ikramov, G.; Kaipov, B. (Inst. of Nuclear Physics, UzSSR). Izv. Akad. Nauk Uz. SSR, Ser. Fiz.-Mat. Nauk, No. 4, 50-2(1966). (In Russian).

Electron paramagnetic resonance (EPR) was used in an investigation of the radiative defects in crystalline quartz activated with impurities of germanium, aluminum, and some alkali metals. Specimens 1 × 4 × 10 mm were irradiated from a ^{60}Co source at 380 R/sec. The irradiation temperature was varied from the boiling point of liquid nitrogen up. During the measurement of the EPR spectrum the principal optical axis of the specimen was placed parallel to the direction of the magnetic field. It was shown that, at any irradiation dose, the EPR lines pertaining to Ge and Al impurities appear independently on the spectrum. Several tens of millions of roentgens are required to saturate the Griffiths-Owen-Ward (GOW) centers; smaller doses, of the order of several millions of roentgens, are required to saturate the 1 and 2 centers. The GOW and 1 and 2 centers were shown to appear as the result of irradiation and disappear, independently of each other, as the result of thermal or optical annealing. Investigation of the absorption spectra showed also that GOW and 1 and 2 centers exist independently from each other, have different probabilities of formation under the effect of ionizing radiation, and can be annealed independently when heated or illuminated. (ATD)

3560 EFFECT OF NEUTRON IRRADIATION ON THE PROPERTIES OF TITANIUM AND CHROMIUM CARBIDES. Kovalchenko, M. S.; Ogorodnikov, V. V. Porosh. Met., Akad. Nauk Ukr. SSR, No. 10, 48-64(Oct. 1966). (In Russian).

The neutron irradiation effects on the structure and properties of TiC and Cr_7C_3 were studied. A change of lattice periods, an increase in electric resistance, microhardness, microbrittleness and decrease of grain size were found. During thermal annealing all these properties return to normal owing to vacancy migration and self-diffusion at high temperatures and to activated movement of dislocations at low temperatures. (auth)

3561 INVESTIGATION OF IRRADIATION EFFECTS IN TITANIUM AND CHROME CARBIDES. Ogorodnikov, V. V.; Kovalchenko, M. S.; Krainii, A. G.; Kutsenok, T. G.; Karasev, V. S.; Slavuta, B. I.; Konozenko, I. D.; Ryzhkov, Yu. T. (Inst. of Problems in Metallography, Kiev. Inst. of Physics, Kiev). Fiz.-Khim. Mekh. Mater., 2: 532-7(1966). (In Russian).

Studies of neutron effects on the properties and structure of chromium and titanium carbides indicated that the cubic-structured titanium carbides have a higher radio-resistance level than hex-

agonal chromium carbides. Neutron irradiation expanded chromium carbide a and c lattices; enhanced the electric conductivity, microhardness, and microfriability of irradiated carbides; and reduced their grain dimensions. When annealed at 400 to 1200°C the properties of irradiated carbides were restored. The effects of the comparatively low temperature (400°C) were due to the activation of the dislocation glide. The higher temperature affected the diffusion processes producing coagulation at dislocation centers and strengthening the material. (R.V.J.)

Plastics and Other Materials

Refer to abstracts 3458, 3915, and 4182.

PHYSICS (GENERAL)

Astrophysics

Refer also to abstracts 3179, 3700, 3702, 3749, 3757, and 3903.

3562 ANCIENT ORIENTAL RECORDS OF NOVAE AND SUPERNOVAE. Xi, Ze-zong; Po, Shu-jen (Academia Sinica, Shanghai). Science, 154: 597-603(Nov. 4, 1966).

Realizing the value of ancient records of nova and supernova to modern astronomical research, a program has been initiated, based on material gathered from many sources, to reexamine and compare the Chinese, Korean, and Japanese historical records. Tables of probable nova and supernova are presented which cover the period of the past 2000 years. Considerable discussion is devoted to "supernova and the origin of radio radiation." (W.D.M.)

3563 ENERGY SPECTRA OF A NUMBER OF CELESTIAL X-RAY SOURCES IN THE ENERGY RANGE FROM 2 TO 60 KILOELECTRON VOLTS. McCracken, K. G. (Southwest Center for Advanced Studies, Dallas). Science, 154: 1000-2(Nov. 25, 1966).

The emission of 20- to 60-keV x rays by an astronomical object in the constellation of Cygnus was observed with a balloon-borne x-ray telescope flown from Hyderabad, India. The balloon data, used in conjunction with data pertaining to the flux in the wavelength range from 2 to 10 Å can be fitted by a power law in photon energy varying as $(h_\nu)^{-1.7}$. The Cygnus object is the brightest object in the sky in the hard x-ray wavelength range and has the hardest spectrum of all observed objects that emit x rays. The astronomical object should be capable of accelerating protons up to energies of the order of 10^{18} eV. Upper limits to the hard x-ray fluxes from Sco XR-1, Cyg XR-2, Oph XR-1, and Ser XR-1 are established; it is shown that the Sco XR-1 spectrum is very soft. (auth)

3564 MAGNETIC FIELDS ON THE QUIET SUN. Livingston, William C. Sci. Amer., 215: No. 5, 54-62(Nov. 1966).

Solar activity is essentially an expression of changing magnetic fields in the sun's atmosphere. Recent observations which substantiate Babcock's comprehensive theory of the 11-year magnetic cycle are discussed. (W.D.M.)

3565 DYNAMICS OF COLLIDING GALAXIES. Alladin, S. M. (Osmania Univ., Hyderabad, India). pp 796-803 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

A theory is developed for the motions of colliding galaxies treating the galaxies as spherically symmetric distribution of stars, and a method is described for estimating the exchange of energy during a collision of galaxies between that corresponding to the center-of-mass motions of the galaxies and that due to their internal structures and motions. Certain implications of the results obtained are mentioned, and a program of further research is suggested. (auth)

3566 LARGE RADIO TELESCOPE FOR OBSERVATIONS OF THE RADIO GALAXIES USING THE METHOD OF LUNAR OCCULATION. Swarup, G. (Tata Inst. of Fundamental Research, Bombay). pp 745-50 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

A large radio telescope is being constructed which has been specially designed for lunar occulation observations of very distant radio galaxies. The instrument has a parabolic cylinder 500 m long and 30 m wide, which will be placed on a hill slope having the same inclination to the horizontal as the latitude of the station (about 11°). This configuration will permit tracking of radio sources for roughly 8 hours a day by a simple motion of the antenna around its mechanical axis. The beam of the antenna will be changed in declination by ±35° by introducing time delays between adjacent dipoles of the long array which will be placed along the focal line of the parabolic cylinder. The instrument will be used mainly for identifications of radio sources and for cosmological investigations by studying number/intensity and number/diameter relationships. It is expected to observe more than 100 occulations per year. Other programs such as flare star observations will also be undertaken. (auth)

3567 SOLAR X-RAY STUDIES. Jones, T. B. (Univ. of Leicester, Eng.). pp 751-5 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

A very brief description is given of some of the solar x-ray studies at present being carried out at the Department of Physics, University of Leicester, U.K. Also mentioned are some of the ionospheric experiments that have been specifically designed to study the effects of the solar x radiation on the earth's atmosphere. (auth)

3568 MEASUREMENTS OF WEAK MAGNETIC AND VELOCITY FIELDS ON THE SOLAR SURFACE. Bhattacharya, J. C. (Kodaikanal Observatory, India). pp 756-62 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

Equipment with highly sensitive photoelectric sensors has been developed for micro study of variations in absorption line profiles in the solar spectra. The spectra are produced by a high-dispersion spectrograph from light from various regions of the solar disc in the 37-m solar telescope in Kodaikanal Observatory. By using electro-optic circular polarization detectors, distortions in the profile of magnetically sensitive lines have been measured, giving quantitatively the longitudinal component of magnetic field over various regions on the sun. With electro-optic chopping arrangement, the Doppler shift of absorption lines have also been measured to study the oscillatory velocity fields. (auth)

3569 STUDIES OF THE ENHANCED SOLAR RADIO EMISSIONS ON METER WAVE LENGTHS. Subrahmanya Sarma, S. B. S. (Indian Inst. of Science, Bangalore, India). pp 763-73 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

Using a simple radio telescope and the associated recording equipment, the study of enhanced solar radio emissions on meter wavelengths is discussed. Some aspects of the radio noise storms (type-I bursts), and type-II and type-IV bursts are discussed. The method of obtaining the velocity of shock wave front responsible for the type-II burst radiation is given. Solar continuum radiation (type-IV bursts) at this meter wavelength shows an interesting property in which the intensity of radiation displays a smooth exponential fall in all the cases. Using this result an approximate method of estimating the magnetic fields (order of magnitude) in the solar corona at the plasma level, during the type-IV events, is indicated. (auth)

3570 HIGH RESOLUTION STUDIES OF THE SUN AT A FREQUENCY OF 612 Mc/s. Swarup, G.; Kapahi, V. K.; Isloor, J. D.; Sinha, R. P. (Tata Inst. of Fundamental Research, Bombay). pp 774-81 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

Two multi-element interferometers having beam widths of 2.3 and 5 minutes of arc in east–west and north–south directions, respectively, were constructed for radio observations of the sun at a frequency of about 612 Mc. Each interferometer uses a simple highly dispersive transmission line of the traveling-wave type which can allow multiple beams by making observations at slightly different frequencies. A strip scan across the quiet sun in an east–west direction was derived. It shows that the radio sun around 50-cm wavelength has sharper features, perhaps more limb brightening, than that derived by O'Brien and Tandberg Hansen in 1954 using a 2-element interferometer. (auth)

3571 ABSORPTION LINES IN MOVING STELLAR ATMOSPHERES. Abhyankar, K. D. (Osmania Univ., Hyderabad, India). pp 782-9 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

Various kinds of mass motions in stellar atmospheres are reviewed. After pointing out the difficulties in the problem of the production of absorption lines in moving atmospheres a numerical method for computing such absorption line profiles is described. The method is applicable to any scattering function and any monotonic velocity law. Some typical results are presented. Variation of the line profile over the disc of the star is discussed and integrated line profiles are given. It is concluded that the bewildering variety of line profiles in supergiant stars like ϵ Aur can be understood with the hypothesis of a field of prominences on their surfaces. (auth)

3572 A STUDY OF ζ CrB A. Abhyankar, K. D.; Sarma, M. B. K. (Osmania Univ., Hyderabad, India). pp 790-5 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

New spectroscopic observations of ζ CrB A are presented. Old and new results about the elements of the orbit are compared. It is inferred that the secondary may be on its way to becoming unstable. (auth)

3573 STUDY OF SOLAR NEUTRONS. Lavakare, P. J. (Tata Inst. of Fundamental Research, Bombay). pp 804-9 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

The present status of the problems of measuring the solar neutron spectrum is briefly reviewed. Some of the theoretical and experimental situations regarding these problems are mentioned. One experiment proposed by the Tata Institute is described. (W.D.M.)

3574 K–Ar AGE DETERMINATION FOR IRON METEORITES. I. THE ISOTOPIC COMPOSITION OF THE PRIMARY POTASSIUM. Kempe, W.; Zaehringer, J. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Geochim. Cosmochim. Acta, 30: 1049-57(Oct. 1966). (In German).

The isotopic composition of primordial potassium was determined in inclusions of five iron meteorites and in one stone meteorite and was compared with terrestrial standards. In iron meteorites with low spallation content, the same isotopic abundance was found for ^{40}K as in terrestrial samples. In the Treysa meteorite spallation-produced ^{40}K could be detected. For the calculation of radiogenic ages of iron meteorites the same ^{40}K abundance of 0.012% can be used as for terrestrial material. From the ^{40}K abundance one can estimate the maximal difference in proton irradiation of some 10^{17} p/cm^2 between terrestrial and meteoritic matter during the early history of the solar system. Iron meteorites are especially interesting, since their origin might have been different from that of terrestrial matter and even from stone meteorites. (auth)

3575 K–Ar AGE DETERMINATION FOR IRON METEORITES. III. POTASSIUM AND ARGON DETERMINATION. Mueller, O.; Zaehringer, J. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Geochim. Cosmochim. Acta, 30: 1075-92(Oct. 1966). (In German).

The K–Ar age of iron meteorites has been reinvestigated. Neutron-activation analysis has been applied for the determination of the total ^{40}Ar and ^{41}K content. The spallation-produced ^{40}Ar could be corrected by means of mass-spectrometric analysis. After irradiation the surfaces of the samples were filed off to avoid potassium contamination. Atmospheric argon could be removed by fractionated degassing at increasing temperatures. The potassium content ranges from less than one ppb to several ppm and the radiogenic ^{40}Ar from 10^{-9} to 10^{-7} cm^3/g. By dissolving the inclusions before evaporating the specimens, fractions of high and low potassium content were obtained. Thus, Ar/K ratios for single fractions could be determined separately. Usually this ratio is much lower for inclusions than for the metal phase and is most likely due to diffusion losses. Meteorites with very low potassium content are difficult to be dated due to argon of other than radiogenic origin. For five iron meteorites with potassium content larger than about 100 ppb, however, the radiogenic ^{40}Ar is proportional to K and reliable K–Ar ages of $6.3 \pm 0.4 \times 10^9$ yr were obtained. Although the cosmic and terrestrial history of these meteorites were quite different, the ages lie within a narrow range. (auth)

3576 ORBITS OF GLOBULAR CLUSTERS AND HIGH-VELOCITY STARS IN A MASS MODEL OF THE GALACTIC SYSTEM. Innanen, Kimmo A. (Univ. of Western Ontario, London). Z. Astrophys., 64: 445-56(1966).

Results are presented of orbit computations in the field of a mass model of the galactic system. It is shown that the exact expressions for the force and gravitational potential of the model should be used for the integrations, rather than empirical expressions. Nearly all the orbits are periodic or nearly periodic in the (ϖ,z) plane; the orbits are also quite sensitive to the initial conditions and to the mass distribution. (auth)

3577 STELLAR EVOLUTION. VI. EVOLUTION WITH NEUTRINO LOSS AND THERMAL PULSE OF HELIUM-SHELL SOURCE IN A STAR OF 5 SOLAR MASSES. Weigert, A. (Max-Planck-Institut fuer Physik und Astrophysik, Munich. Univ., Goettingen, Ger.). Z. Astrophys., 64: 395-425(1966). (In German).

The core contraction after the central helium burning is recalculated for a 5-$M_\odot$ star. Energy losses due to photoneutrinos and plasma neutrinos are now taken into account. When these losses become larger than the energy released by the contraction, the central temperature begins to decrease before the ignition temperature of carbon burning is reached. The neutrino luminosity of the models remains small. A local thermal instability appeared in the helium-burning shell source of the models. The resulting thermal runaway was followed numerically. After a rapid increase of temperature and a rapid expansion, the region of the shell source becomes stable; then it slowly contracts until it is again unstable and so on. Six of these "thermal pulses" of the shell source are calculated. They appear with growing amplitude in time intervals of some 10^3 years. (auth)

3578 STELLAR EVOLUTION. V. THE CARBON-FLASH IN A STAR OF 5 SOLAR MASSES. Kippenhahn, R.; Thomas, H.-C.; Weigert, A. (Max-Planck-Institut fuer Physik und Astrophysik, Munich. Univ., Goettingen, Ger.). Z. Astrophys., 64: 373-94(1966). (In German).

The onset of carbon burning in a star of 5 solar masses after exhaustion of its central helium content is computed. Since the ignition of carbon takes place in a degenerate region, the flash phenomenon occurs. The computations are carried on until degeneracy is removed and nuclear burning becomes stable. During this phase the helium burning shell becomes less and less important as the hydrogen is again ignited at the interface between the outer hydrogen-rich envelope and the helium core. No neutrino processes due to weak interaction (such as plasma neutrino or photoneutrino emission) are taken into account. (auth)

3579 RANDOM FRAGMENTATION IN TWO AND THREE DIMENSIONS. Kiang, T. (London Univ.). Z. Astrophys., 64: 433-9(1966).

It is pointed out that, unlike the schemes of random fragmentation in 2 or 3 dimensions so far proposed, the dissection of an area or a volume into the Voronoi or Delaunay figures associated with a random distribution of points, involves no arbitrary choice. The size distributions of the 2- and 3-dimensional random Voronoi figures were studied in a Monte Carlo manner. The results, in terms of the standardized size x (= actual size/average size), are that, in 2 dimensions, 4 x is a γ (4) variate for $2.5 < x < \infty$, and that in 3 dimensions, 6 x is a γ (6) variate, for $0.35 < x < \infty$. (It is rigorously shown that in 1 dimension, 2 x is a γ (2) variate for $0 < x < \infty$.) (auth)

3580 THE LAW OF INTERSTELLAR EXTINCTION IN PERSEUS. Johnson, Harold L.; Mendoza V., Eugenio E. (Univ. of Arizona, Tucson. Univ. Nacional de Mexico, Mexico City). Ann. Astrophys., 29: 525-30(Sept.-Oct. 1966).

New observations on M-type supergiants in the region of the double cluster in Perseus have yielded, when interpreted according to the usual procedures, an interstellar extinction curve quite similar to that already found in Cepheus. Furthermore, the M-stars gave the same extinction curve from 0.36 to 3.4 μ as did the early-type stars in the same region, confirming the usefulness of M supergiants in the determination of interstellar reddening. According to these interpretations, $R = A_V/E_{B-V}$ is greater than 3.0, the value obtained from the variable extinction method, and may be as high as 5.6, the value obtained from cluster diameters. (auth)

3581 VARIATION IN CONTINUUM BRIGHTNESS AND EQUIVALENT WIDTHS OF LINES IN SUNSPOT PENUMBRAE. Bhatnagar, A. (Kodaikanal Observatory, India). Z. Astrophys., 64: 460-3(1966).

Variation in the continuum brightness and in the equivalent widths of lines were observed in the sunspot penumbral spectra. Darker regions in the continuum of the penumbrae show widening of lines, while the brighter parts show decrease in widths. A negative correlation between the continuum brightness and the equivalent widths of lines is obtained. The brightness variation in the penumbrae suggests that it is due to aggregates of individual penumbral filaments. (auth)

3582 THEORETICAL DYNAMIC SPECTRA OF SOLAR TYPE-I STORM BURSTS. Fung, P. C. W.; Yip, W. K. (Univ. of Tasmania, Australia). Planet. Space Sci., 14: 1139-48(Nov. 1966).

In a recent report by Fung and Yip (submitted to Australian J. Phys. (1966)) the theory of cyclotron radiation from electron streams in the o mode is proposed to be the origin of solar type-I noise storm. The theory is studied in detail and found to agree very well with the observational data. Apart from the properties investigated in the above report, the features in theoretical dynamic spectra of storm bursts subsequent to the cyclotron theory have not been discussed. These aspects are considered here, and it is found that the calculated theoretical dynamic spectra of storm

bursts agree well with observations. The frequency drift character of different storm bursts is explained. (auth)

3583 UPPER LIMIT TO THE NEUTRAL HYDROGEN DENSITY IN THE HALO REGIONS OF SPIRAL GALAXIES. Roberts, Morton S. (National Radio Astronomy Observatory, Green Bank, W. Va.). Phys. Rev. Lett., 17: 1203-4(Dec. 5, 1966).

Because of the fact that radiation from hydrogen in the general vicinity of the sun will completely mask that from a low-density hydrogen halo, a search was made for such a halo in other spiral galaxies. NGC 4244 and NGC 7640, both late-type Sc systems, were chosen for study. Observations were made with the National Radio Astronomy Observatory 300-ft telescope which has a half-power beamwidth of 10′ at the hydrogen-line wavelength. It is concluded that, except for unknown pressure effects and the possibility of accretion, applying an upper limit on the halo neutral atomic-hydrogen density of 1×10^{-3} cm^{-3} to the Milky Way appears reasonable. (W.D.M.)

3584 STABILITY OF GRAVITATING STREAMS. Talwar, S. P.; Kalra, G. L. (Univ. of Delhi). Ann. Astrophys., 29: 507-16(Sept.-Oct. 1966).

The problem of stability of gravitating streams which are moving either with interfacial contact only or are completely interpenetrating into each other was investigated, in view of its importance for fragmentation of interstellar clouds. In each case the classical Jeans' wavelength for fragmentation is considerably diminished due to streaming. The effect of uniform magnetic field is also included for the case when the interpenetrating streams are fully ionized. It is found that the gravitational effects are negligible for high-frequency oscillations in plasmas. It is also shown that the conventional two-stream instability in laboratory plasmas is rendered unstable for all wavelengths propagating transverse to the streaming. (auth)

3585 RELATION BETWEEN BASIC COMPONENTS OF SOLAR RADIO EMISSION AT CENTIMETER AND DECIMETER WAVELENGTHS AND THE SOLAR CYCLE. Basu, D. (Univ., Calcutta). Nature 212: 804-5(Nov. 19, 1966).

The data were examined for each year corresponding to intermediate periods of activity with the view of determining the exact nature of the annual variation of the quiet sun radio emission during a solar cycle. The investigation on B component in relation to the solar cycle was extended to as many frequencies as possible in order to determine the width of the waveband. (W.D.M.)

3586 RADAR STUDIES OF THE SUN AT 38 Mc. James, Jesse C. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J., 146: 356-66(Nov. 1966).

About 1000 daily radar experiments have been made of the Sun at El Campo, Texas, since April, 1961. Some of the results of these experiments are presented. The average intensity, mean range, and range depth of the solar echo were found to vary with sunspot number, but correlations of these parameters on a daily basis were low. The radar signal is reflected from coronal irregularities that are moving at velocities up to 200 km/s. At times there is an increase in the echo intensity, and when this happens there are often high-corona irregularities moving at about 20 km/s. Some possible reasons for these effects are discussed. (auth)

3587 STELLAR NEUTRON SOURCES. Reeves, Hubert (Univ., Montreal. Univ. Libre, Brussels). Astrophys. J., 146: 447-61(Nov. 1966).

The nuclear physics of neutron emission in stellar interiors is reviewed. The reaction rates of a few neutron-producing processes are evaluated with the optical model of the nucleus; the uncertainties are assessed. Estimates are made of various neutron irradiation parameters throughout the course of stellar evolution. These estimates are compared with our present knowledge of the formation of heavy elements. (auth)

3588 PROBLEM OF THE QUASI-STELLAR OBJECTS. Burbidge, Geoffrey; Hoyle, Fred. Sci. Amer., 215: No. 6, 40-52(Dec. 1966).

The history of quasars is briefly reviewed and their general properties are discussed. The arguments both pro and con on their origin, whether cosmological or local, are given. All hypotheses on the physical processes taking place in the quasars are mentioned and the problems inherent in each of them are discussed. (W.D.M.)

3589 TIDES IN A CLOSE BINARY STAR. II. Zahn, Jean-Paul (Institut d'Astrophysique, Paris). Ann. Astrophys., 29: 489-506 (Sept.-Oct. 1966). (In French).

The major properties of tides in a close binary star were established, and their effects on the dynamic and nuclear evolution of the system were studied (Ann. d'Astrophys., 29: 313-30(1966)). In this second part, the coefficient of turbulent viscosity in a convective zone is evaluated. Using the phenomenological approach of Heisenberg, an attempt is made to take into account the loss of efficiency of viscous friction when the oscillation period of the macroscopic velocity field is shorter than the life time of a turbulent element. With this coefficient of viscosity the torque applied by the convective tide, out of resonance, first to a star having an outer convective zone, and then to a Cowling-type star, is determined. The resolution of the Poisson equation is discussed in an appendix. (auth)

3590 DETAILED ANALYSIS OF ATMOSPHERES OF EARLY K-TYPE STARS. Cayrel De Strobel, G. (Institut d'Astrophysique, Paris). Ann. Astrophys., 29: 413-88(Sept.-Oct. 1966). (In French).

The physical parameters and the chemical composition of the atmosphere of seven stars of early type K, as well as of a comparison star, ϵ Virginis, were obtained. Of the eight stars, two are main-sequence K stars and six are K stars of luminosity class III and II. Seven of them have never been studied at high dispersion. The Sun was the comparison star for the two dwarfs. The dispersion was 9.7 Å mm^{-1} for the blue region and 12.4 Å mm^{-1} for the yellow–red region. These spectra were compared with theoretical line computations using a grid of 52 model atmospheres. (auth)

3591 PHOTOSPHERIC TEMPERATURE DISTRIBUTIONS FROM CENTER-LIMB VARIATION OF CENTRAL INTENSITIES. Schmalberger, D. C. (Univ. of Rochester, N. Y.). Ann. Astrophys., 29: 255-62(May-June 1966).

The validity of the so-called fishbone effect of the solar photosphere was tested by use of a different model atmosphere than that used by the proponents of this effect and a model of anisotropic depth-dependent microturbulence. The effect was not found in this analysis and reasons were therefore sought in both the excitation temperatures and the depths of formation of the lines involved. Center-limb variations of central intensities were used to derive excitation temperatures and depths of formation for 6 metal lines. The resulting temperature distributions were within ±40°K of their mean and did not show the fishbone effect to the degree which demonstrated the importance of nonhomogeneous structure in the photosphere. The most probable cause for disagreement of depths of formation seems to be the model atmosphere used. A tacit assumption involved in the fishbone effect analysis suggests the effect provides dubious evidence for photospheric nonlocal thermodynamic equilibrium and that the center-limb variation of central intensity is negligibly influenced by inhomogeneous structure through rugosity effects. It is concluded that inhomogeneous structure is not so important as to affect, through rugosity effects, the center-limb variation of central intensity. (BBB)

3592 FORBUSH EFFECTS AND THE POSSIBILITY OF THE INTERACTION OF MAGNETIC BOTTLES PRODUCED BY SOLAR FLARES. Gopasyuk, S.; Krivsky, L. (Astronomical Inst., Czechoslovak Academy of Sciences, Ondrejov). Nature, 212: 782-4(Nov. 19, 1966).

An attempt was made to correlate the intensity of cosmic rays detected during 1959–64 by the neutron monitor at the Deep River station with a published list of solar flares. During the period studied, eighty typically shaped Forbush effects were found, and for 51 of them the related solar flares were identified with a relatively high degree of certainty. The study led to the following conclusions: (1) flares which occur near the east solar limb are relatively important in producing the Forbush effect; (2) flares which occur in the northern hemisphere are more effective in producing Forbush effects than those in the southern hemisphere (44 to 7); (3) Forbush effects often appear in connection with recurrent flares. (W.D.M.)

3593 SEARCH FOR RADIO EMISSION FROM BLUE STELLAR OBJECTS AND SEYFERT GALAXIES. Kellermann, K. I.; Pauliny-Toth, I. I. K. (National Radio Astronomy Observatory, Green Bank, West Virginia). Nature, 212: 781-2(Nov. 19, 1966).

At centimeter wavelengths, upper limits of 2 flux units and 0.5 flux units at 2 cm and 3.75 cm, respectively, have been reported for the blue stellar objects TON 730, TON 256, and BSO 1, all of which have significant redshifts and can, therefore, be considered to be quasi-stellar galaxies. Observations were made of these three objects and a number of other blue stellar objects in order to determine whether these upper limits can be reduced. Observations were made at 1.95 and 6 cm with the 140-ft telescope between Feb. and June 1966. No significant radiation was detected from any of the objects investigated except the Seyfert galaxies NGC 1068 and NGC 1275 and possibly NGC 7469. (W.D.M.)

3594 DECREASE IN THE INTENSITY OF HYDROGEN LINES IN THE SOLAR PHOTOSPHERE AND CHROMOSPHERE.

Rouse, Carl A. (Naval Research Lab., Washington, D. C. Univ. of California, Berkeley). Nature, 212: 803-4(Nov. 19, 1966).

In a study of the number of levels and the population of upper levels of hydrogen, Ivanov-Kholodnyi and Nikolskii state "in prominence and chromospheric spectra, it has been found that near the series limit the lines do not merge because of their broadening and convergence, but instead they disappear because of a rapid fall in intensity." It is indicated how this fall in intensity is in excellent qualitative agreement with numerical solutions of the Schrödinger equation using the complete screened Coulomb potential and photospheric densities obtained from the solar model, provided an effective screening distance is identified with the radius of the mean atomic volume. (W.D.M.)

3595 THE FREE–FREE ABSORPTION OF Cl^-. Kandel, R. (Observatoire de Paris, Meudon, France). Ann. Astrophys., 29: 531-2(Sept.-Oct. 1966).

In an earlier note (Compt. Rend., 262B: 373(1966)), a first-approximation calculation of the free–free absorption coefficient of Cl^- was reported in which only the s–p and p–s transitions were considered. Calculations are reported which show that the d and f states must also be considered. (W.D.M.)

3596 NATURE OF SOLAR M-REGIONS. Basler, Roy P. (ITT Electro-Physics Labs., Inc., Hyattsville, Md.). Planet. Space Sci., 14: 1193-1206(Nov. 1966).

Using the daily average absorption of cosmic radio noise at College, Alaska, as an index of solar corpuscular bombardment, auroral absorption is shown to exhibit a well-defined 27-day recurrence tendency and so is interpreted as an M-region effect. On the basis of the absorption data, several conclusions are reached about the nature of solar M regions: (1) M regions are detectable within a year after sunspot maximum; (2) M-type particle streams subtend an angle of about 60 to 70°, on the average; (3) M regions are contained in the sunspot zones and follow the characteristic migration toward the equator during the sunspot cycle; and (4) M regions are definitely not identified with centers of activity. This last conclusion is also verified using the planetary magnetic activity index. (auth)

3597 K–Ar AGE DETERMINATION FOR IRON METEORITES. II. SPALLOGENIC ^{40}Ar AND ^{40}Ar–^{38}Ar IRRADIATION AGES. Laemmerzahl, P.; Zaehringer, J. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Geochim. Cosmochim. Acta, 30: 1059-74(Oct. 1966). (In German).

A first attempt to determine the spallation ^{40}Ar in iron meteorites is reported. A new extraction technique for metallic samples with atmospheric contamination as low as 10^{-9} cm^3 STP ^{40}Ar was developed to determine the spallation-produced ^{40}Ar in iron meteorites. The samples were degassed in steps with increasing temperature. The atmospheric and radiogenic components were released at low temperatures. At higher temperature the $^{40}Ar/^{38}Ar$ values remain constant and give an upper limit of the spallation ratio. The spallation-produced ^{40}Ar is mainly important as a correction in the determination of the radiogenic ^{40}Ar content. The precision achieved is, however, high enough to determine also cosmic-ray exposure ages. The measured $^{40}Ar/^{38}Ar$ spallation ratios range from 0.188 to 0.226 and depend on the time of the decay of the cosmic-ray-produced ^{40}K. By comparison with exposure ages deduced from other isotopes relative production rates of $^{40}Ar/^{38}Ar = 0.186 \pm 0.005$ and of $^{40}K/^{38}Ar = 0.97 \pm 0.05$ are derived. The production cross sections of ^{39}K, ^{40}K and ^{41}K in iron targets bombarded with 575-MeV protons were also measured. For ^{40}K, a value of 9.2 ± 0.8 mbarn was obtained. This is in agreement with the ^{40}K spallation yield calculated from the cosmic-ray-produced K isotopes in iron meteorites. The $^{40}Ar/^{38}Ar$ determinations of this work give cosmic-ray exposure ages which are in good agreement with the ages obtained from the ^{40}K–^{41}K method. (auth)

3598 DISPLACEMENT OF THE RAYS EMITTED BY A DISTANT ASTRONOMICAL OBJECT. de Broglie, Louis. Compt. Rend., Ser. B, 263: 589-92(Aug. 29, 1966). (In French).

It is shown that the great spectral displacements observed with the quasars are not in contradiction with the relativistic theory of the Doppler effect. Another interpretation of the displacement of spectral rays emitted by a distant astronomical object is proposed in which it is not necessary to use the Doppler effect resulting from an expansion of the universe. (tr-auth)

3599 RELATIVE SUNSPOT NUMBERS AND THE TIME OF RISE. Xanthakis, J. (Research and Computing Center, Athens). Bull. Astron. Inst. Czech., 17: 215-22(1966).

A study was made of the variation in the relative sunspot numbers within each sunspot cycle and from cycle to cycle. The analytical relations found were as follows: (a) A relation representing the maxima of the mean annual relative sunspot numbers corresponding to the successive sunspot cycles as a function of the time of rise T_R and an exponential term Y of the form $Y = n(10-n)^{-1} \exp\{n-9\}$. The parameter n assumes the values $n = 0,1,2,\ldots,9$ for the successive cycles of each decade of sunspot cycles, the value $n = 0$ corresponding to the cycles $N = -10, 0, 10, 20, 30, \ldots$ etc. (b) A relation representing the variation in the mean annual relative sunspot numbers within each sunspot cycle as a function of T_R and Y. This relation represents the mean annual relative sunspot numbers observed during the years 1766–1963 with an accuracy equal to 85.5%. (c) A relation representing the lowest values of the mean monthly relative sunspot numbers observed during the successive years of the sunspot cycles Nos. 7 to 19 (1823–1963) as a function of T_R and Y. (d) A relation representing the highest values of the mean monthly relative sunspot numbers observed during the successive years of the sunspot cycles Nos. 7 to 19 (1823–1963). Besides the time of rise T_R and the exponential term Y this relation contains also a periodic term X_R with a period equal to 8 sunspot cycles. (auth)

3600 THE NON-RADIAL STRUCTURE OF CORONA 5303 A FOLLOWING PROTON FLARES. Krivsky, L. (Astronomical Inst., Czechoslovak Academy of Sciences, Ondrejov); Makarov, V. I. Bull. Astron. Inst. Czech., 17: 234-42(1966).

Examined by photometric cross section was the rough structure of corona 5303 Å after flares near the limb with emissions of cosmic, subcosmic, and corpuscular radiation. The processed coronal data are from the High-Altitude Astronomical Station, Kislovodsk (USSR). The results of 9 processed cases show that projections of coronal condensations above the active regions, wherein proton flares occurred a range of hours before, are not aimed vertically upwards (radially), but are, as a rule, considerably deflected. The formation of regions with enhanced intensity of radiation, in certain cases to at least 350,000 km of altitude, may be due to the increased concentration of particles in the corona as a trail left by the passage of the accelerated particles from the flare located in lower region. (auth)

3601 TYPE IV BURSTS. II. IN ASSOCIATION WITH PCA EVENTS. Fritzova-Svestkova, L.; Svestka, Z. (Astronomical Inst., Czechoslovak Academy of Sciences, Ondrejov). Bull. Astron. Inst. Czech., 17: 249-61(1966).

The new catalog of 177 type–IV bursts recorded during 1956–1963 in combination with a newly compiled list of 124 PCA's during that period made it possible to investigate 81 events of type-IV bursts associated with injections of high-energy protons into the polar ionosphere. A newly introduced classification of PCA importance, together with the extended number of correctly associated events, leads to some new, improved, or verified results concerning PCA production by proton flares occurring on the sun. Seasonal variation of the PCA occurrence and delay time, western preference for flares producing strong PCA events and an absence of this preference for flares causing weak PCA's, a dependence of the delay time on the PCA importance, and a general tendency of some active regions to emit or not to emit high-energy protons from type-IV burst flares to the Earth, are among the conclusions which are summarized. (auth)

3602 FLARES WITH IV-TYPE BURSTS AND THE CORONA IN THE 11-YEAR CYCLE. Krivsky, L. (Astronomical Inst., Czechoslovak Academy of Sciences, Ondrejov); Krueger, A. Bull. Astron. Inst. Czech., 17: 243-8(1966).

The occurrence of 190 flares with IV-type bursts in connection with the radiation of corona Fe XIV 5303 Å in the course of the 11-year solar cycle (1954–1965) was investigated. The existence of a second maximum in 1960 in the occurrence of flares accompanied by the IV-type was again confirmed. The occurrence of these flares, especially in so far as they were connected with emissions of sub-cosmic radiation (PCA effect) most likely had two occurrence maxima not only in the 1954–1965 cycle, but also in the foregoing cycles. The relation between the occurrence of flares with the IV type and the more permanent absolute intensity of the green light corona 5303 Å in time and latitude distribution was examined. The knowledge of this relation might be used for forecasting from coronal measurements the occurrence of such flares in the course of the activity development. The character of the two maxima in the 11-year cycle of activity is examined for further parameters of the solar radio emission by comparing data from the years 1957 and 1960. The cause of the second maximum is evidently inherent in the very substance of flare processes. Although the over-all activity of the Sun is lower in the descending phase of the cycle, the physical conditions in the photosphere, chromosphere, and corona, on the other hand, are more favorable for the formation of such processes in connection with the complex event of a proton flare where particles get accelerated, released, or accumulated. (auth)

3603 THE STRUCTURE OF THE SOLAR CHROMOSPHERE. II. SPECTROHELIOGRAMS IN λ 10830 A AND THEIR INTERPRE-

TATION. Zirin, Harold; Howard, Robert (California Inst. of Tech., Pasadena. Carnegie Inst. of Washington, Washington, D. C.). Astrophys. J., 146: 367-71(Nov. 1966).

Spectroheliograms made in the λ 10,830 Å line of He I showed a network pattern of absorption which coincides with the Ca and Hα network. The absorption in 10,830 is limited to the edges of the network cells, to plages, and filaments. It was concluded that the edges of the network cells are the only areas in the chromosphere where temperature and density are sufficiently high to excite the 2^3S level. (auth)

3604 EFFECTS ON THE SOLAR WIND OF ROTATION, SELF-GRAVITATIONAL ATTRACTION, AND MAGNETIC FIELDS. King, J. H. (Aerospace Corp., El Segundo, Calif.); Carovillano, R. L. Astrophys. J., 146: 372-82(Nov. 1966).

The linearized equations governing first-order deviations from the critical, transonic solar-wind flow are examined in special cases. The imposition of a boundary condition corresponding to solar rotation yields the result that the angular momentum of a fluid element is conserved as the element is convected outward with the solar wind. It is demonstrated that, in the domain of existence of the solar wind, coronal self-gravitational attraction is exceedingly small relative to the forces of solar gravity and kinetic pressure. The original neglect of both solar rotation and coronal self-attraction is justified. A general expression for the interplanetary magnetic field, as drawn out from the rotating Sun by a radial plasma flow modified transversely by rotation, is derived. It is demonstrated that, in the region of maximum acceleration, the transverse magnetic force is comparable in magnitude to the zero-order hydrodynamic forces originally incorporated into the model. The desirability of an explicitly hydromagnetic theory of the solar wind is indicated. (auth)

3605 THE ABUNDANCES OF LITHIUM AND BERYLLIUM IN SOME F DWARFS AND K GIANTS. Conti, Peter S.; Danziger, I. J. (Carnegie Instution of Washington, Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 146: 383-91(Nov. 1966).

The Li and Be abundances in ten F dwarfs and two K giants were determined. The analysis was made using equivalent widths and line strengths predicted from a grid of model atmospheres. Curve-of-growth effects were accounted for in an empirical fashion. For the F dwarfs, a large range in the Li overabundances, from a factor 100 to less than 10 times the solar value, was found. The Be abundances were similar to the solar value but differ from it in several stars. The Li/Be ratio ranges from about 75 to near unity. It is doubtful that errors in the analysis could account for all this difference. The Li/Be results, when combined with those for G dwarfs studied by Merchant, suggest that Li depletion occurs in main-sequence stars of type F and later. In addition to the above evidence, since some of these stars contain ^{6}Li, this depletion must be on a "long-time scale" so that both ^{6}Li and ^{7}Li can be depleted. There is at present some uncertainty in the expected Li/Be production ratio by spallation. Of the two K giants studied, α Boo has no detectable Li or Be, so the ratio is unknown; β Gem has much less Li than the Sun but about the same Be abundance. This evolved star represents a clear case of depletion of Li but not of Be. (auth)

3606 A GENERAL VARIATIONAL PRINCIPLE GOVERNING THE OSCILLATIONS OF GASEOUS MASSES IN THE PRESENCE OF MAGNETIC FIELDS. Kovetz, Attay (Hebrew Univ., Jerusalem). Astrophys. J., 146: 462-70(Nov. 1966).

A variational principle, applicable to the adiabatic oscillations of a perfectly conducting, self-gravitating, gaseous configuration pervaded by a magnetic field, is derived. Special attention is given to the case in which the magnetic field extends to the exterior of the configuration, and the principle is stated in a form which does not require the trial function to satisfy any boundary conditions. (auth)

3607 IONIZATION FRONTS FOR H II REGIONS WITH MAGNETIC FIELDS. Lasker, Barry M. (Princeton Univ., N. J.). Astrophys. J., 146: 471-9(Nov. 1966).

The steady-state ionization fronts expected about H II regions with weak to moderate magnetic fields in their initial H I clouds are considered in the magnetohydrodynamic approximation and with simplifying thermodynamical assumptions. For R-type ionization fronts, the supersonic ones expected to propagate directly into the undisturbed neutral gas bounding young H II regions, such fields have only small effects. Larger effects occur for D-type ionization fronts, the ones expected to drive strong shocks in older nebulae. If the shock is adiabatic, magnetic pressure in the H I shell between it and the ionization front is weak; and simple solutions result for the ionization front. However, if the shock tends to be isothermal, high density in the H I shell makes the magnetic pressure dynamically important there. Then at some field orientations three solutions to the conservation equations for ionization fronts result, different branches of the solutions being required at various orientations. Here a proper choice of ionization fronts is unclear and must be decided as part of the whole dynamical problem. Speculative flow patterns are discussed for this case, and the possibility is raised that highly aspherical H II regions may evolve. (auth)

3608 ABSOLUTE RADIO LUMINOSITY AND SURFACE BRIGHTNESS OF EXTRAGALACTIC RADIO SOURCES. Heeschen, D. S. Astrophys. J., 146: 517-22(Nov. 1966).

An empirical relation between absolute ratio luminosity and surface brightness is found for extragalactic radio sources. Spiral and irregular galaxies are distinctly separated from radio galaxies. Quasi-stellar radio sources form a continuation of the radio galaxy sequence if they are at distances as given by their redshifts. The volume emissivity of a spiral or radio galaxy is roughly proportional to the third power of the radius of the emitting region. In quasi-stellar sources and the most luminous radio galaxies, the volume emissivity is inversely related to radius. The peculiar objects NGC 1068 and M82 and the cores of core-halo sources deviate markedly from the general sequence. The sequence may provide a means of obtaining luminosity distances of extragalactic sources. (auth)

3609 VELOCITY DISTRIBUTION OF MAIN-SEQUENCE STARS. Dennis, Tom R. (Princeton Univ., N. J.). Astrophys. J., 146: 581-3(Nov. 1966).

It has been known for some time that the dispersion in the velocity perpendicular to the plane of the Galaxy increases as one considers samples consisting of increasingly later spectral types. Evidence is presented that tends to support the hypothesis that this effect is a manifestation of a correlation between age and W dispersion. Photometric parallaxes and space-motion vectors were computed for the stars in the Strömgren–Perry (1962) catalog of uv by photometry for 1217 bright stars. Only those stars with $b-y \geq 0.220$ were considered. In order to limit the discussion to population-I stars, those with metal-line index $m_1 \geq 0.025$ were deleted from the sample. (W.D.M.)

3610 A POSSIBLE OLD NOVA NEAR SCO X-1. Johnson, Hugh M.; Stephenson, C. B. (Lockheed Missiles and Space Co., Palo Alto, Calif. Kitt Peak National Observatory, Tucson, Ariz. Case Inst. of Tech., Cleveland). Astrophys. J., 146: 602-4 (Nov. 1966).

The discovery of a 12th-magnitude variable star resembling an old nova is reported, which may be related to the strongest known x-ray source in Scorpius (Sco X-1). The star was found as a variable star on Warner and Swasey Observatory objective-prism plates which had been taken with the object of searching for optical evidence of Sco X-1, and the spectrum was photographed at a resolution of about 3 to 5 Å on June 27, 1966, at the Kitt Peak Observatory with the Cassegrain spectrograph of the 84-inch reflector. The position of the star $16^h17^m1, -15°31'$(1950) differs from the position of Sco X-1 by three times the published probable error. (W.D.M.)

3611 LUNAR OCCULTATION AND PROVISIONAL IDENTIFICATION OF MSH 21-23. Brown, Larry W. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 146: 605-9 (Nov. 1966).

The radio source MSH 21-23 was observed by means of a lunar occultation on June 18, 1965 at the NASA Data Acquisition Facility. The occultation provided a possible optical counterpart to the radio source, as well as position and diameter measurements. The object has several characteristics similar to a quasar, such as color excess, near-stellar appearance, and radio emission. The angular diameter is small, although it appears to be larger than the average quasar. More optical evidence will be needed to identify this source. (W.D.M.)

3612 ABSOLUTE PROPER MOTIONS OF 3C 345, 3C 351, 3C 446, AND MSH 14-121. Sanders, W. L. (Univ. of California, Mount Hamilton). Astrophys. J., 146: 609-10(Nov. 1966).

Proper-motion determinations for quasars have been made previously in which the reference frame has been field stars to which statistical corrections were applied in order to bring the frame to an absolute system. An effort to obtain proper motions against an absolute frame directly, without recourse to statistical corrections, is reported. Four fields of the Lick Proper Motion Program were rephotographed with the 20-inch Carnegie Astrograph. The measurements were carried out on a Gaertner long-screw measuring engine. It was concluded that there is no proper motion for these objects. (W.D.M.)

3613 THE BOLOMETRIC CORRECTIONS AND EFFECTIVE TEMPERATURES OF TWO GIANT STARS IN THE GLOBULAR CLUSTER M3. Johnson, H. L. (Univ. of Arizona, Tucson). Astrophys. J., 146: 613-14(Nov. 1966).

UBVRIJK photometric observations were obtained of two giant-

star members of the globular cluster M3. The observational data are listed. The numbers of the stars are those of Sandage (1953). The two stars are nearly identical, and the mean colors are tabulated. The observations were made with the 60-inch photometric telescope at the Catalina Station of the Lunar and Planetary Laboratory. (W.D.M.)

3614 INTERPRETATION OF THE ABSORPTION SPECTRUM OF 3C 191. Bahcall, John N. (California Inst. of Tech., Pasadena). Astrophys. J., 146: 615-18(Nov. 1966).

Observations of a number of absorption lines in the spectrum of the quasi-stellar source 3C 191 (Z = 1.95) have been recently reported. An interesting feature and simple interpretation of the absorption spectra of 3C 191 is pointed out which becomes apparent if the redshift of each absorption line is plotted versus the ionization potential of the ion which has one more electron than the absorbing ion (e.g., the redshift of the CII absorption line is plotted versus the ionization potential of CI). The interpretation suggests that the absorbing envelope of 3C 191 is expanding away from the source of the emission lines with a speed $\approx 10^3$km/sec. (W.D.M.)

3615 THE WEAKNESS OF HELIUM LINES IN GLOBULAR CLUSTER AND HALO B STARS. Greenstein, Jesse L.; Muench, Guido (Carnegie Institution of Washington, Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 146: 618-20(Nov. 1966).

A discussion is presented on the weakness of helium lines in globular cluster and halo B stars. A montage of Palomar 190 Å/mm spectra of halo and globular-cluster stars is shown which clearly demonstrates the extreme weakness of the He I, $2^3P^0-n^3D$ lines. (W.D.M.)

3616 MECHANISM FOR MASS EJECTION IN RED GIANTS. Wickramasinghe, N. C.; Donn, B. D.; Stecher, T. P. (California Inst. of Tech., Pasadena. Jesus Coll., Cambridge, Eng. Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 146: 590-3(Nov. 1966).

In recent papers Weymann has discussed various mechanisms which have been proposed for the ejection of matter from red giants such as α Orionis. The main difficulty is to explain the observed apparently constant outflow of matter beyond 10 stellar radii with a speed ~10 km/sec which is less than the escape velocity. Purely hydrodynamic theories seem to demand an extensive hot corona surrounding the star for which no observational evidence is available. Both the constant velocity nature of the flow as well as the observation that ejection seems to set in very suddenly with B−V appear to suggest strongly a mechanism involving the formation of grains. A model is proposed in which graphite grains forming near the photospheric boundary serve to couple the radiation field to the gas and continually remove mass from the star. Objections to this model do not appear to hold for the case of particles with dimensions of a few hundredths of a micron. (W.D.M.)

3617 H-ALPHA EMISSION REGIONS IN IRREGULAR TYPE II GALAXIES. Hodge, Paul W. (Univ. of Washington, Seattle). Astrophys. J., 146: 593-4(Nov. 1966).

Discovery of the recent explosive history of the peculiar galaxy M82 raises the question of whether gross explosive phenomena of this type might not be common occurrences. Accordingly, a search was carried out for further examples of M82-type explosive galaxies which was limited to galaxies classified as Irr. II. Hα photographs were obtained of several Irr. II galaxies using the Lick 120-inch telescope (103aE emulsion and RG-1 filter). (W.D.M.)

3618 DIGITAL RADIO POLARIMETER OBSERVATIONS OF SPECTRAL TYPE III SOLAR DECAMETRIC BURSTS. Bhonsle, R. V.; Fejfar, A.; Lusignan, B. B. (Stanford Univ., Calif.). Astrophys. J., 146: 595-7(Nov. 1966).

The solar bursts of spectral type III have typical duration of about 10 sec at decametric wavelengths, and they often occur quasi-periodically, forming a group that may last several minutes. At the Stanford Center for Radar Astronomy, a digital radio polarimeter has been developed for studies of solar and Jovian decametric emissions with high time resolution. Observations of the polarization behavior of three groups of spectral type-III solar bursts at 26.3 and 22.2 Mc are reported. The characteristics of the three groups are plotted. (W.D.M.)

3619 INVERSE COMPTON RADIATION IN QUASI-STELLAR OBJECTS. Woltjer, L. (Columbia Univ., New York). Astrophys. J., 146: 597-9(Nov. 1966).

In a recent note Hoyle, Burbidge, and Sargent (Nature, 209:751 (1966)) discussed the energy losses for electrons in quasars caused by the inverse Compton effect. It is shown that their arguments in favor of a local theory for the quasar depend strongly on the assumed isotropy of the relativistic electrons and that, when the electrons move in a narrow cone ($\approx 10°$) around the field lines of a radial field, the difficulties seen by Hoyle, et al. are eliminated. In this case the electrons are streaming out from the quasar. This is dynamically the most likely situation since for plausible parameters the total charged-particle energy involved will be far larger than the magnetic energy. This picture leads to some interesting possibilities for relating the quasars to the extended radio sources. The source of the relativistic particles is not discussed, but implicitly the source region is taken to be small compared to the region where most synchrotron radiation is produced. (W.D.M.)

3620 INTERGALACTIC ATOMIC NEUTRAL HYDROGEN. I. Koehler, J. A. (Mount Stromlo Observatory, Canberra, Australia); Robinson, B. J. Astrophys. J., 146: 488-503(Nov. 1966).

Observations of intergalactic atomic hydrogen (H I) made with the C.S.I.R.O. 210-foot radio telescope are presented. H I in the Virgo cluster of galaxies was detected in absorption. A similar absorption feature was not detected for the Fornax cluster of galaxies. Intergalactic H I was searched for in emission but was not detected. General noncluster intergalactic H I was detected in absorption in the spectrum of the radio source Fornax A. (auth)

3621 INTERGALACTIC ATOMIC NEUTRAL HYDROGEN. II. Koehler, J. A. (Mount Stromlo Observatory, Canberra, Australia). Astrophys. J., 146: 504-16(Nov. 1966).

The spin temperature of intergalactic atomic hydrogen (H I) is calculated as a function of electron density and kinetic temperature. This calculation is a revision of previous work by Field and results in a considerably lower minimum spin temperature for H I in the medium. The observations of Koehler and Robinson are discussed, and total H I mass of the Virgo cluster of galaxies and an upper limit to the H I mass of the Fornax cluster of galaxies are given. In the case of the Virgo cluster, it is also possible to put an upper limit to the coexisting electron density. The H I mass of the Virgo cluster is insufficient to appreciably alter the apparent instability of the cluster as given by the virial theorem. Some estimates of the H I density in the general noncluster intergalactic medium are given. (auth)

3622 SPECTRAL SHIFTS IN QUASI-STELLAR OBJECTS. Noerdlinger, Peter D. (Univ. of Chicago); Jokipii, J. R.; Woltjer, L. Astrophys. J., 146: 523-7(Nov. 1966).

The hypothesis that quasi-stellar objects have been ejected with relativistic velocities from many comparatively nearby galaxies is considered. The expected frequency distribution of blueshifts and redshifts is calculated. If all members of a given group of objects with similar velocities could be observed, redshifts would be more numerous than blueshifts, but because the blueshifted objects are much brighter, they can be seen at much larger distances. If the groups are created at random through a Euclidean portion of space and a sample brighter than some limiting magnitude is examined, blueshifts should be far more numerous than redshifts. This appears contrary to observation. (auth)

3623 RADIO EMISSION FROM CLUSTERS OF GALAXIES. Fomalont, E. B.; Rogstad, D. H. (California Inst. of Tech., Pasadena). Astrophys. J., 146: 528-41(Nov. 1966).

A radio survey of 21-cm continuum emission in 111 clusters of galaxies within a distance of 230 Mpc contained in Abell's catalog was performed with the Owens Valley twin-element interferometer. Of these clusters 43% have radio emission greater than 0.2 flux units. Their radio luminosities are compared to the luminosity function of Longair, with the conclusion that a large fraction of the strong radio emitters are in Abell-type clusters. The statistical properties of the sample indicate a possible correlation of detection probability with cluster richness. The radio structures and optical identifications suggest the emission is associated with the brightest cluster member or members, which have, in several cases, been classified as the D galaxy of Morgan. (auth)

3624 PRIMORDIAL HELIUM ABUNDANCE AND THE PRIMORDIAL FIREBALL. II. Peebles, P. J. E. (Princeton Univ., N. J.). Astrophys. J., 146: 542-52(Nov. 1966).

Results are presented of a calculation of the ^{3}He, ^{4}He, and deuterium abundances produced in the early stages of expansion of the Universe. It is assumed in the calculation that the present temperature of the primordial fireball is 3°K, and the abundances are computed for two values of the present mean density of matter in the Universe, and for a range of possible changes in the time scale for expansion of the early Universe. (auth)

3625 SIMPLIFIED METHOD OF COMPUTING THE ELECTRIC CONDUCTIVITY IN SUNSPOTS AND IN THE PHOTOSPHERE. Kopecky, M. (Astronomical Inst., Czechoslovak Academy of Sciences, Ondrejov). Bull. Astron. Inst. Czech., 17: 270-2(1966).

A simplified method of computing the electric conductivity σ in sunspots and in the photosphere is proposed. The method was derived from an empirically determined linear relation between log σ and log (p_e/n). (auth)

3626 LITHIUM OBSERVATIONS IN THE PLEIADES AND IN F STARS IN THE FIELD. Danziger, I. J.; Conti, Peter S. (Carnegie Institution of Washington, Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 146: 393-8 (Nov. 1966).

Determinations of lithium abundance are given for sixty-nine early F field stars and six stars in the Pleiades Cluster. They were calculated from estimated equivalent widths and predicted line strengths derived from a grid of model atmospheres. A wide range of Li content was found in the field stars, the maximum abundance exceeding the solar value by a factor of more than 50. Although the correlation of Li abundance with estimated age is poor, there is a tendency for some of the youngest stars to have the highest Li content. In the Pleiades Cluster, the average Li content of the G and F stars is similar. This is not true in the Hyades Cluster where, at type G5, there is a distinct drop in the Li content, which may be interpreted as caused by convective depletion. The time scale for depletion in G stars must then lie between the ages of the Pleiades and the Hyades. There is a real variation from star to star in the Li content of the Pleiades F stars that is similar to that found in the Hyades. If it is caused by convective depletion, then some stars must have a depletion time scale less than the age of the Pleiades. The differences are possibly regulated by the secondary effects of rotation or some other circulation mechanism operating in F stars. On the other hand, they may reflect differences in the initial Li content. (auth)

3627 APPROXIMATE ABUNDANCES OF THE LIGHT ELEMENTS FROM THE MOLECULAR SPECTRA OF M AND S STARS. Spinrad, Hyron (Univ. of California, Berkeley); Vardya, M. S. Astrophys. J., 146: 399-410(Nov. 1966).

Relative abundances of the light elements H, C, N, and O were computed for several M stars from the intensities of observed molecular bands. The infrared bands of H_2, CO, H_2O, CN, TiO, and VO were used to establish molecular concentrations. Molecular equilibria for a wide range of atomic compositions were fitted to the observations through fairly detailed model atmospheres and crude "one-slab" models. The large uncertainty in the temperature scale for cool stars is a severe problem; temperature errors could introduce systematic abundance errors. In cases where a photospheric temperature can be specified, atomic abundances may be obtained with some precision. The results for the M stars α Ori, and R Leo are O/C = 1.05, O/H ~ 10^{-3}, and N/C ~ 2. A mild S star, χ Cyg, seems to have O/C = 1.04 and a high nitrogen abundance. One high-velocity Mira variable, W Hya, may have a higher O/C ratio than the low-velocity stars. The large nitrogen excess, relative to the solar N/C value ~0.2, is interpreted as being due to the presence of mixed material brought up from a region of previous CNO bi-cycling. The low O/C ratio for most M-giant stars is difficult to explain; it may be due to ^{12}C from ^4He burning. (auth)

3628 BINARY STARS AMONG CATACLYSMIC VARIABLES. VIII. PHOTOELECTRIC OBSERVATIONS OF TWELVE OLD AND DWARF NOVAE. Mumford, George S. (Tufts Univ., Medford, Mass. Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J., 146: 411-17(Nov. 1966).

Since 1962 a number of old, recurrent, and dwarf novae have been monitored in an attempt to detect eclipses. The negative results obtained for SS Aurigae, TZ Persei, and SU Ursae Majoris are described. In addition, photoelectric observations have been made for lesser periods of time on RX Andromedae, YZ Cancri, SS Cygni, AB Draconis, AH Herculis, DI Lacertae, CN Orionis, RU Pegasi, and GK Persei. From the small sample represented, it appears that the characteristic, short-period outbursts—flickering—may be correlated with nova activity. (auth)

3629 EARLY EVOLUTION OF A STAR OF 1.2 SOLAR MASSES. Hallgren, E. L.; Demarque, P. R. (Univ. of Toronto). Astrophys. J., 146: 430-6(Nov. 1966).

Evolutionary models for a star of 1.2 $M_\odot$ are constructed. The initial composition is X = 0.67 and Z = 0.03 with a mixing length equal to the pressure scale height. The star is evolved through the stages of hydrogen depletion, gravitational contraction, burning of the shell source, and a second gravitational contraction. The evolutionary track, in its main features, is found to be more similar to that of a 2.0 $M_\odot$ star than to that of a 1.0 $M_\odot$ star. (auth)

3630 PRE-WHITE-DWARF EVOLUTION. I. Vila, Samuel C. (Univ. of Rochester, N. Y. Indiana Univ., Bloomington). Astrophys. J., 146: 437-46(Nov. 1966).

The evolution of model sequences for 1 and 1.2 $M_\odot$ of high Z with energy sources due to gravitational contraction only is studied on the assumptions of energy loss due to photons plus neutrinos and due to photons alone. These models are intended to represent stars that have undergone extensive mass loss; energy-generating outer layers have already been lost and the further evolution reduces to contraction and release of gravitational and thermal energies, finally leading to white-dwarf stars. The inclusion of the energy loss due to neutrino production by a direct neutrino–electron interaction causes a period of fast collapse (~10^4 years) with high luminosity (~10^4 $L_\odot$) analogous in some respects to a recently proposed evolution of the nuclei stars of planetary nebulae. (auth)

Atomic and Molecular Physics

Refer also to abstracts 3832, 3852, and 3965.

3631 (AERE-R-5172) A MONTE CARLO TREATMENT OF THE INTERACTION OF AN ELECTRON BEAM WITH A HEAVY TARGET. Ruffle, M. P. (Atomic Energy Research Establishment, Harwell (England)). Sept. 1966. 60p. Dep. BIS $1.80. HMSO 9s.

The general strategy adopted and the treatment of the various reactions involved in investigating the interaction of an electron beam with a heavy target by a Monte Carlo computer program are described. The purpose of the program is to predict the distribution of the heat generated and the neutrons produced. Some results for typical targets are shown, and the performance of the program is discussed. (auth)

3632 (JINR-P-2896) RASSEYANIE ELEKTROMAGNITNYKH VOLN NA SISTEME DIPOL'NYKH TSENTROV. (Electromagnetic Wave Scattering With the Dipole Center System). Lyuboshits, V. L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1966. 20p. (In Russian). Dep. mn.

The problem of the electromagnetic wave scattering with two stationary dipole centers is solved. A system of algebraic equations is obtained, which determines the electromagnetic wave scattering amplitude with the system consisting of an arbitrary number of dipole centers. This system is generalized to the case of macroscopic medium with chaotic and uniform distribution of the scattering centers. The resonance frequency shift and the resonance width change are considered for the electromagnetic wave scattering in the macroscopic medium. (auth)

3633 (JINR–P2-2949) VYSSHIE POPRAVKI K RASSHCHEPLENIYU OSNOVNOGO UROVNYA POZITRONIYA. I. (The Highest Corrections to the Positronium Ground State Level Disintegration. I.). Tyukhtyaev, Yu. N.; Faustov, R. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 8p. (In Russian). Dep. mn.

With the help of the quasipotential equation the contributions from the second- and fourth-order diagrams in the positronium ground-state level disintegration are calculated with an accuracy of the sixth order relative to the fine structure constant α. (auth)

3634 (JINR–P4-2929) ISSLEDOVANIE ROLI TREKHCHASTICHNYKH SIL V PROBLEME TRITIYA PRIMENENIEM NELOKAL'NOGO FAKTORIZUYUSHCHEGOSYA POTENTSIALA. (Study of the Role of Three-Body Forces in the Tritium Problem Using a Non-Local Factorizing Potential). Vashakidze, I. Sh.; Chilashvili, G. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 12p. (In Russian). Dep. mn.

The influence of three-body forces in the tritium problem is investigated using a nonlocal factorizing potential. It is shown that the experimental value of the tritium coupling energy can be obtained when three-body forces are considered to be of the repulsive nature. (auth)

3635 (N-66-19870) ELECTROMAGNETIC INELASTIC VERTEX. Micheli, J. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). Dec. 1965. 24p. (TH-117). CFSTI $3.00 cy, $0.65 mn.

The matrix element structure of an electromagnetic current between two different spin particles was studied by the electromagnetic interactions of photodisintegration and photoproduction, and evaluation of the total inelastic electron-nucleus scattering cross sections. (M.O.W.)

3636 (N-66-29474) ON VAINSHTEIN'S METHOD APPLIED TO THE ELECTRON IMPACT EXCITATION AND IONIZATION OF ATOMS. Omidvar, Kazem (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). June 1966. 24p. (NASA-TM-X-55501; X-641-66-245). CFSTI $3.00 cy, $0.65 mn.

In previous papers Vainshtein and collaborators have introduced a method of calculation which in some respects gives better agreement with observation than do other methods. In their derivation the integral for the excitation and ionization amplitudes is treated

approximately. In this paper this integral is derived exactly, and it is shown that an overall improvement in agreement with observation is obtained. The theory has some features in common with the close-coupling approximation. In particular, at the threshold of excitation and ionization the cross section has oscillatory behavior. A feature of the theory not presently understood is that the exchange amplitude is indeterminate. (auth)

3637 (ORNL-4019) A FABRY-PEROT DUOCHROMATOR FOR THE MEASUREMENT OF SMALL WAVELENGTH DISPLACEMENTS OF SPECTRAL LINES. Hirschberg, Joseph G.; Fried, Walter I. (Oak Ridge National Lab., Tenn.). Nov. 1966. Contract W-7405-eng-26. 18p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

A two-channel duochromator was constructed utilizing the high luminosity and dispersion of the Fabry-Perot interferometer. The duochromator was tested by measuring the Zeeman effect of a singlet line in the spectrum of helium. Its sensitivity to small wavelength shifts was initially determined to be about 7 parts in 10^9. (auth)

3638 (SLAC-67) TABLES OF γ SPECTRA FROM e^+-HYDROGEN ATOM COLLISIONS. Dufner, A.; Swanson, S.; Tsai, Y. (Stanford Linear Accelerator Center, Calif.). Aug. 1966. Contract AT(04-3)-515. 135p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The theoretical values of the total cross sections for the annihilation processes: $e^+ + e^- \rightarrow 2\gamma$ and its radiative corrections and $e^+ + e^- \rightarrow 3\gamma$, and the differential cross sections for the bremsstrahlung processes: $e^+ + e^- \rightarrow e^+ + e^- + \gamma$ and $e^+ + p \rightarrow e^+ + p + \gamma$ are tabulated for fixed photon scattering angle and positron energy. The range of positron beam energy values is from 30 BeV to 0.50 BeV, for a variety of optimal scattering angles. A sufficiently dense spectrum of photon energies is given in each table to allow the application of graphing and numerical integration techniques for obtaining total bremsstrahlung cross sections at each photon scattering angle and initial positron energy value. The specific forms of the cross sections which were evaluated to produce the tables are discussed. (M.H.R.)

3639 IONIZATION IN COLLISIONS OF SLOW ATOMS. Podlubnyi, L. I. (Moscow Power Engineering Inst.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 1, 37-41(1966). (In Russian).

Inelastic collisions of slow atoms, connected with the transition of one atom from the ground state into the continuous spectrum, are considered. The analysis is carried out in the adiabatic region and nonstationary perturbation theory is used. The formulation of the problem is in the form of an integro-differential equation. In the region of medium energies (~10^2 to 10^3 eV), the cross sections for ionization and recombination are obtained by a semiempirical method based on these calculations for the reaction $He + He \rightarrow He + He^+ + e$. The calculated values (10^{-16} to 10^{-17} cm^4-sec for recombination and 1.8×10^{-14} cm^2 for ionization) are in good agreement with the available experimental data. (ATD)

3640 PHYSICAL PROPERTIES OF MANY-ELECTRON ATOMIC SYSTEMS EVALUATED FROM ANALYTICAL HARTREE-FOCK FUNCTIONS. III. ELECTRIC FIELD GRADIENTS AND QUADRUPOLE COUPLING CONSTANTS. Malli, Gulzari; Fraga, Serafin (Univ. of Alberta, Edmonton). Theoret. Chim. Acta, 6: 54-63(1966).

Numerical values are presented for the electric field gradients (q) and nuclear quadrupole coupling constants (eqQ) for some neutral atoms and their positive and negative ions. The angular dependence of the field gradient integrals is tabulated for configurations involving equivalent p and d electrons, for LS-coupling and central-force-field functions (e.g., Hartree-Fock functions). Correction factors are given by which it would be necessary to multiply the Hartree-Fock results in order to obtain the experimental values. Also given are the calculated values of q for the ground states of various atomic systems involving p^n and d^n configurations, and the values for some excited states with configurations p^n. Results are compared with those obtained by Platas for the 5-electron isoelectronic series $(1s)^2(2s)^2(2p)$, ^2P, occurring in the first row of the periodic table. Other tables show the quadrupole coupling constants, evaluated from the field gradients obtained in this calculation and using the nuclear quadrupole moments given by Kopfermann and Ramsey. Comparison is made with the available experimental values, the agreement being considered extremely satisfactory. It is concluded that Hartree-Fock functions constitute an adequate basis for the evaluation of field gradients and quadrupole coupling constants. (BBB)

3641 ION-MOLECULE REACTIONS AND REACTIONS IN CROSSED MOLECULAR BEAMS. Henchman, M. J. (Univ. of Leeds, Eng.). Ann. Rep. Progr. Chem., Chem. Soc. London, 62: 39-62(1965).

The use of molecular-beam techniques is reviewed, studies of single-collision events being divided into ion-neutral reactions and neutral-neutral reactions. Topics considered are recent developments in instrumental techniques, reaction types, theoretical and experimental investigation of rates, mechanisms, collision-induced dissociation, and chemi-ionization. It is concluded from this survey of 161 publications that sufficient results are now available for a comparison of the characteristics of the ion-neutral and neutral-neutral reaction studies. Several comparisons were made. (TSS)

3642 PARTICLE EMISSION IN LASER-SURFACE INTERACTIONS. Ready, J. F.; Bernal, G. E.; Levine, L. P. (Honeywell Corp. Research Center, Hopkins, Minn.). pp 993-8 of Proceedings of the National Electronics Conference. Vol. XXII. Chicago, National Electronics Conference, Inc., 1966.

These studies of particle emission produced in a laser-surface interaction indicate that even at relatively low laser powers, copious emission of high energy particles occurs. The high-energy particles contain both ions and neutral molecules with energies of the order of 100 eV and consist mainly of adsorbed surface species. In addition a larger amount of thermally desorbed neutral gas is desorbed. (auth)

3643 SCATTERING OF PARTIALLY COHERENT RADIATION IN NEUTRAL GAS. Gabriel, G. S. (Univ. of Notre Dame, Ind.). pp 56-60 of Proceedings of the National Electronics Conference. Vol. XXII. Chicago, National Electronics Conference, Inc., 1966.

It was demonstrated that observed deviations from Rayleigh-Smolukowski theory of scattering in neutral gas can be attributed to partial coherence of the incident field. Scattered intensity was formulated in terms of correlation functions which clearly show that scattered field arises from two factors: fluctuations of the incident field and of the molecular density. (auth)

3644 FOCUSING AND SEPARATION OF HYDROGEN ATOMS USING A PERIODIC LONGITUDINAL MAGNETIC FIELD. Checkrahamatoula; Septier, Albert (Univ., Paris, Orsay, France). Compt. Rend., Ser. B, 263: 505-8(Aug. 17, 1966). (In French).

The optical properties of a magnet with a periodic field $B(z) = B_0 \sin pZ$ were studied. It was shown that this system could replace, in a hydrogen maser, the hexapole and quadrupole lenses commonly used for focusing and separation of polarized atoms. (tr-auth)

3645 THEORY OF THE DISSOCIATIVE RECOMBINATION AND ASSOCIATIVE IONIZATION OF HYDROGEN. Nielsen, Svend E.; Dahler, John S. (Univ. of Minnesota, Minneapolis). J. Chem. Phys., 45: 4060-79(Dec. 1, 1966).

A brief survey is given of the experimental information presently available on dissociative recombination and the dynamically inverse process of associative ionization. The mechanism by which the reactions can occur are described in terms of adiabatic potential-energy curves of the ion and of the quasi-molecule formed from the union of ion and electron. The paucity of detailed information about the relevant potential-energy curves suggests that one focus attention upon hydrogen, the system about which the most is known. A mathematical theory is then constructed, which takes as its basic ingredients a Coulomb-Born description of the scattering of ion and electron and an adiabatic, or perturbed-stationary-state, treatment of atom-atom collisions. A very general approach is abandoned in favor of one based upon an approximate wave function, which includes coupling of only a few entrance and final-state channels. Equations are derived for the scattering amplitudes in the two sets of channels and formulas are given for the relevant cross sections. (auth)

3646 VELOCITY DISTRIBUTION MEASUREMENTS OF MOLECULAR BEAMS SCATTERED FROM SOLID SURFACES. Hagena, Otta Friedrich (Univ. of Virginia, Charlottesville). Appl. Phys. Lett., 9: 385-7(Nov. 15, 1966).

Using a nozzle-type molecular beam with highly uniform velocity and high intensity and a sensitive time-of-flight detection system allows the measurement of the complete distribution of speeds after scattering the incident beam from a solid surface. With a "dirty" metal target at room temperature and argon as beam gas, it is found that the thermal spread of velocities in the scattered beam is at least three times larger than the thermal spread of velocities in the incident beam. While a complete thermal accommodation of the incident atoms would result in the same speed distribution for all scattering angles, the measurements show an angular dependence of the thermal spread and the mean speed of the scattered atoms. (auth)

3647 ENERGY SHIFTS AND INTENSITY RATIOS IN THE MUONIC X-RAY SPECTRA OF THE ^{206} ^{207} ^{208}Pb ISOTOPES. Ehrlich, R. D.; Fryberger, D.; Jensen, D. A.; Nissim-Sabat, C.; Powers, R. J.; Sherwood, B. A.; Telegdi, V. L. (Univ. of Chicago). Phys. Lett., 23: 468-70(Nov. 21, 1966).

The isotope shifts for the muonic x rays of lead were found to be about half those predicted for an $A^{\frac{1}{3}}$ dependence for the nuclear radius in agreement with optical data. The $K\alpha_1/K\alpha_2$ and $L\beta_1/L\alpha_1$ intensity ratios are significantly smaller than predicted. (auth)

3648 ENERGY LOSS MEASUREMENTS IN ANTHRACENE, TERPHENYL, AND PLASTIC SCINTILLATOR FOR PROTONS AND DEUTERONS IN THE ENERGY RANGE 100 TO 900 keV. Kloppenburg, J.; Flammersfeld, A. (Univ., Goettingen, Ger.). Z. Phys., 196: 424-32(1966). (In German).

Experimental determinations of stopping cross sections of anthracene, terphenyl and plastic scintillator were made for protons and deuterons in the energy range 100 to 900 keV. A semiconductor counter was used to measure the energy loss of the particles in the stopping materials. The thickness of the crystals of anthracene and terphenyl was measured by interferometry. The thickness of the foils of plastic scintillator was obtained by weighing a known area of foil. Range–energy curves for protons and deuterons in anthracene and terphenyl were computed by integration of the energy loss curves. (auth)

3649 ENERGY LOSS SPECTRA OF ALKALI METAL HALIDES AND THE METALS Cu, Ag, AND Au AND THEIR COMPARISON WITH OPTICAL MEASUREMENTS. Creuzburg, M. (Univ., Hamburg). Z. Phys., 196: 433-63(1966). (In German).

Energy loss spectra of 50-keV electrons have been measured in transmission of the alkali halides and of Cu, Ag, and Au at zero scattering angle. These spectra are compared with the quantity $-\mathrm{Im}(1/\epsilon)$ determined from optical measurements. The general agreement is good, especially in the low energy loss region. In the case that the foil thicknesses could be measured, the absolute intensity of $-\mathrm{Im}(1/\epsilon)$ is found to be equal or up to three times larger than from optical data. In addition to the sharp low-energy peaks (excitons), characteristic sharp peaks are found at higher energies: 60 eV for the Li halides, 33 eV for the Na halides, and 20 eV, 17 eV, and 13 eV for the K, Rb, and Cs halides, respectively. These peaks are very little shifted by the different anions in the crystal lattice and may be due to excitons caused by alkali band transitions. Several peaks were examined in the loss spectra of LiF, KCl, KBr, and the Na halides: The angular dependence of the loss intensity is in agreement with theory. The dispersion of the peaks is much smaller than for plasma losses. The temperature dependence of the peak energy has been found quite different for different peaks. (auth)

3650 EFFECT OF MONOPOLE ELECTRIC CHARGES ON THE MOBILITY OF A NATURAL AEROSOL. Salbreiter, H.; Stierstadt, K. (Univ., Munich). Z. Phys., 196: 495-503(1966). (In German).

The size distribution of natural aerosol particles with radii from 10^{-6} to 10^{-5} cm was measured by investigation of the distribution of thoron decay products on the mobility spectrum. In addition we used an artificial ionization of the particles traversing a corona discharge. Thus the efficiency of the mobility spectrometer could be increased by a factor of four (as a function of corona current). The electrical charge distribution on the particles having passed the corona is out of equilibrium. Therefore the mobility spectrum can be reduced to a size spectrum only by means of an experimentally determined calibration function. (auth)

3651 NEW THEORETICAL VALUES FOR THE LAMB SHIFT. Soto, M. F. Jr. (Columbia Univ., New York). Phys. Rev. Lett., 17: 1153-5(Nov. 28, 1966).

The exact evaluation of fourth-order radiative corrections to the energy levels of hydrogenic atoms is considered. Those parts of the calculation that were previously estimated are calculated exactly, and recalculations are done and checks are provided on all parts of the calculation. Feynman diagrams that were calculated for the fourth-order radiative corrections to the scattering of an electron in a Coulomb field are shown, and theoretical and experimental values of the Lamb shift are given for H, D, and He^+. (J.F.P.)

3652 ANNIHILATION OF SLOW POSITRONS IN HELIUM. Prokop'ev, E. P. (Karpov Inst. of Physics and Chemistry, Moscow). Teor. Eksp. Khim., 2: 543-5(July-Aug. 1966). (In Russian).

The complex positron half-life annihilation spectrum consists of three components: the short-life $\tau_3 \sim 2 \times 10^{-10}$ sec, produced by positron pair annihilation; $\tau_2 \sim 11.2 \times 10^{-8}$ sec, corresponding to the orthopositronium annihilation; and the most intense components, $\tau_1 \sim 2 \times 10^{-9}$ sec, produced by annihilation of free positrons. Angular distribution measurements of annihilation radiation confirmed the importance of the free positron in the annihilation processes. Analytical studies were made of thermalized positron annihilation processes and of the practical applications of the annihilation method. Results indicate that the process is feasible for determining cross sections for positron scattering on complex atoms and molecules. (R.V.J.)

3653 INJECTION OF INTENSE, LARGE-DIAMETER ION BEAMS INTO LOW-DENSITY GASES. Martin, D. H.; Hutchins, C. L.; McClenny, W. A.; Stallings, C. H.; Wakefield, R. H. (North Carolina State Univ., Raleigh). J. Appl. Phys., 37: 4317-19(Nov. 1966).

Experimental tests of a method for injection of large-diameter, intense positive ion beams into low-density gases are described. Twenty-keV, 15-mA beams are projected through a supersonic annular gas nozzle that furnished a large aperture (3.18 cm dia), while providing differential pumping to allow up to 30 m torr pressure in the collision chamber. Calorimetrically measured attenuations of large argon- and helium-ion beams in several gases are given and compared with similar data for small-aperture beams. Possible extensions of the method are discussed. (auth)

3654 AN ELECTRON TRANSPORT MODEL FOR THE PREDICTION OF X-RAY PRODUCTION AND ELECTRON BACKSCATTERING IN ELECTRON MICROANALYSIS. Brown, D. B.; (Univ. of Southern California, Los Angeles); Ogilvie, R. E. J. Appl. Phys., 37: 4429-33(Nov. 1966).

An electron transport equation has been applied to the case of electron–specimen interaction, which is associated with the problems in electron microanalysis. It has been solved numerically to predict the distribution depth of x-ray production $\varphi(\rho x)$, the x-ray absorption correction factor $f(\chi)$, and the distribution in energy and angle of electrons backscattered. These results are compared with available experiments data for Al, Cu, and Au. (auth)

3655 CONFIGURATION INTERACTION IN TWO- AND THREE-ELECTRON ATOMS. Brown, Robert T.; Fontana, Peter R. (Univ. of Michigan, Ann Arbor). Contract AT(11-1)-1112. J. Chem. Phys., 45: 4248-55(Dec. 1, 1966).

The ground states of the first four members of the helium isoelectronic series and the 2^2S and 2^2P states of lithium are calculated using a configuration-interaction expansion in a complete denumerable set of single-particle functions, with one adjustable scale parameter. The best energies for the two-electron systems, obtained with 120-term expansions, are $E(H^-) = -0.52748$, $E(He) = -2.90335$, $E(Li^+) = -7.27945$, and $E(Be^{2+}) = -13.65504$, in units of e^2/α_0. The energies for all but He are lower than any heretofore obtained with a configuration-interaction approach. The dependence of energy on scale factor is found to be very pronounced, in contrast to the corresponding behavior for wave functions that contain the interparticle coordinates explicitly. The best energies for the lithium states, obtained with 208-term expansions, are $E(2^2S) = -7.47369$ and $E(2^2P) = -7.40366$. The 2^2S energy is not as good as has been obtained with either expansions in terms of interparticle coordinates or configuration interaction with many nonlinear parameters. The 2^2P energy is of approximately the same accuracy but is lower than any previously published. (auth)

3656 MEASUREMENT OF THE STOPPING POWERS OF C, Ca, Au, AND CaF_2 FOR PROTONS WITH ENERGIES BETWEEN 0.4 AND 6 MeV. Gorodetzky, S.; Chevallier, A.; Pape, A.; Sens, J. Cl.; Bergdolt, A. M.; Bres, M.; Armbruster, R. (Univ., Strasbourg). Nucl. Phys., A6702: 133-44(1967). (In French).

In order to determine certain effective cross sections of proton-induced reactions on calcium fluoride and on calcium, the stopping power of these two materials was measured for protons of energies from 0.4 to 6.0 MeV. Analogous measurements were also made on carbon and on gold. (Carbon is frequently used as a target supporting material, while gold serves as a reference for preparing highly pure absorbers.) The results obtained agree with previous experimental and theoretical results. The mean ionization potential for each material was also calculated. (G.O.Y.)

3657 HIGHER TRANSITIONS IN π-MESONIC ATOMS. Jenkins, David A.; Kunselman, Raymond (Univ. of California, Berkeley). Phys. Rev. Lett., 17: 1148-52(Nov. 28, 1966).

Measurements were made on the $3d \rightarrow 2p$, $4f \rightarrow 3d$, and $5g \rightarrow 4f$ π-mesonic x-ray energies and widths for a selection of isotopes from $16 \leq Z \leq 94$. The object was to measure phase shifts and widths of the pion energy levels caused by the strong-interaction force of the nucleus. The results of the measurements are presented. (M.O.W.)

3658 COLLISION FREQUENCIES AND ENERGY TRANSFER: ELECTRONS. Banks, Peter (Institut d'Aeronomie Spatiale de Belgique, Brussels. Pennsylvania State Univ., University Park). Planet. Space Sci., 14: 1085-1103(Nov. 1966).

A study was made of the problem of elastic collisions and energy transfer between gases which have separate Maxwellian velocity distributions. It is shown that the expression for the en-

ergy transfer rate obtained by Desloge for gases of arbitrary temperature and particle mass can be adapted into a convenient form which involves a ratio of particle masses, the difference in the gas thermal energies, and a collision frequency for energy transfer. An analysis is then made of the collision frequency in terms of an average momentum transfer cross section which is defined for conditions of thermal nonequilibrium. The general equations are next specialized to consider the problem of elastic electron collisions in heavy particle gases. To obtain useful numerical expressions for electron–neutral particle collision frequencies and energy transfer rates, an analysis has been made of the momentum transfer cross sections for N_2, O_2, O, H, and He. Calculations have also been made of the Coulomb momentum transfer cross section, collision frequency, and energy transfer rate. (auth)

3659 MASS-SCATTERING CROSS SECTION OF THIN CARBON FILMS. Sarkar, N. H. (Saha Inst. of Nuclear Physics, Calcutta). J. Appl. Phys., 37: 4389-94(Nov. 1966).

Mass-scattering cross sections of thin carbon films were determined experimentally for 60- and 80-kV electrons at the scattering angles of 2.23×10^{-3}, 4.25×10^{-3}, 9.76×10^{-3}, and 1.86×10^{-2} radian. This was done by densitometric determination of the contrast in the electron microscope (Siemens Elmiskop I) negatives of thin carbon films of known mass thickness, on the basis of a rigorous contrast–density relationship. These experimental results and those due to Leisegang, Lippert, and Komoda have been compared with the values calculated from the theories of Lenz, of Burge and Smith, and of Sarkar. The experimental results are found to agree quite well with the theory of Sarkar. (auth)

3660 CORRELATION PROBLEM IN ATOMIC AND MOLECULAR SYSTEMS. CALCULATION OF WAVEFUNCTION COMPONENTS IN URSELL-TYPE EXPANSION USING QUANTUM-FIELD THEORETICAL METHODS. Cizek, Jiri (Inst. of Physical Chemistry, Prague). J. Chem. Phys., 45: 4256-66(Dec. 1, 1966).

A method is suggested for the calculation of the matrix elements of the logarithm of an operator that gives the exact wave function when operating on the wave function in the one-electron approximation. The method is based on the use of the creation and annihilation operators, hole–particle formalism, Wick's theorem, and the technique of Feynman-like diagrams. The connection of this method with the configuration-interaction method as well as with the perturbation theory in the quantum-field theoretical form is discussed. The method is applied to the simple models of nitrogen and benzene molecules. The results are compared with those obtained with the configuration-interaction method considering all possible configurations within the chosen basis of one-electron functions. (auth)

3661 KINETIC ENERGIES OF IONS PRODUCED BY LASER GIANT PULSES. Gregg, David W.; Thomas, Scott J. (Univ. of California, Livermore). J. Appl. Phys., 37: 4313-16(Nov. 1966). (UCRL-14673).

Kinetic energies of ions produced by focusing laser giant pulses on surfaces of Li, LiH, Be, C, Al, S, Zn, and Ag were measured. The mean-squared ion velocity and the velocity squared of the highest-energy ions detected are presented as a function of laser giant pulse peak intensity. The mean squared ion velocity increased proportionally to approximately the square root of the giant pulse peak intensity for the lower atomic weight materials, and varied with approximately the 0.33 power of the intensity for the higher atomic weight materials. Average ion kinetic energies as high as 2000 eV were detected. (auth)

3662 MEASUREMENT OF THE CHARACTERISTIC ENERGY LOSS OF ELECTRONS IN LIGHT OXIDIZABLE METALS IN AN ULTRAHIGH VACUUM. Kunz, Christof (Univ., Hamburg). Z. Phys., 196: 311-31(1966). (In German).

Energy losses of 34-keV electrons penetrating thin foils of Li, Na, K, Rb, Cs, Ca, Sr, Ba, Mg, and Al are measured. The metals are evaporated and investigated in ultrahigh vacuum ($\sim 10^{-9}$ torr) with an apparatus constructed especially for this purpose. For all the alkali metals free-electron-like behavior is found with a surface and a volume plasma loss. Ca and Sr show more complicated structures. For most of the volume losses half width, dispersion and cutoff are measured. Surface losses are investigated for oxide-free surfaces with respect to angular distribution, dispersion and total excitation probability, and also the displacement due to oxidation is measured. A narrow loss line from the excitation of a surface wave at the Al/Mg interface is found at 12.8 eV in good agreement with the theoretically predicted value. (auth)

3663 INVESTIGATION OF THE PRODUCTION AND THE DETECTION OF ALKALI METAL ATOMIC BEAMS IN THE ENERGY RANGE BETWEEN 6 AND 4000 eV. Hollstein, M.; Pauly, H. (Univ., Bonn). Z. Phys., 196: 353-64(1966). (In German).

An alkali metal atomic beam source for the 6 to 4000 eV energy range is described. The fast atomic beam is obtained by the neutralization of an alkali metal ion beam and is detected by surface ionization on an unheated filament. The processes involved in collisions of fast alkali metal atoms with a tungsten surface are investigated and the behavior of the atoms is compared with the behavior of the corresponding ions. (auth)

3664 HYPERFINE STRUCTURE INVESTIGATION OF THE Re-I SPECTRUM WITH A DIGITAL-RECORDING DOUBLE FABRY–PEROT SPECTROMETER. THE QUADRUPOLE MOMENTS OF ^{185}Re, ^{187}Re, ^{186}Re, AND ^{188}Re. Kuhl, J.; Steudel, A.; Walther, H. (Technische Hochschule, Hanover). Z. Phys., 196: 365-84(1966). (In German).

The hyperfine structure of the Re-I lines λλ 4889 Å ($5d^5 6s 6p\ z\,^8P_{5/2} - 5d^5 6s^2 a\,^6S_{5/2}$) and 5275 Å ($5d^5 6s 6p z\,^8P_{5/2} - 5d^5 6s^2 a\,^6S_{5/2}$) was measured by a photoelectric recording double Fabry-Perot spectrometer using enriched isotopes of ^{185}Re and ^{187}Re, which have been excited in liquid-air-cooled hollow cathodes. Besides the usual recording the signal was also measured by a digital voltmeter and punched into paper tape making it possible to evaluate the measurements by a computer. The linewidth obtained in the experiments was small enough that besides the splitting of the ^8P states also the splitting of the ground state could be detected in asymmetries of the hyperfine structure components. By the mathematical analysis of the components it was possible to derive the quadrupole coupling constant B of the $5d^5 6s^2 a\,^6S_{5/2}$ ground state: $B = 1.6\ (8) \cdot 10^{-3}$ cm^{-1} for ^{185}Re and ^{187}Re. The quadrupole moments of ^{185}Re and ^{187}Re have been estimated from B ($z\,^8P_{3/2,5/2}$) with LS coupling eigenfunctions considering relativistic effects: $Q(^{185}\text{Re}) = 2.30\ (4)\ [90] \times 10^{-24}$ cm^2 and $Q(^{187}\text{Re}) = 2.20\ (4)\ [90] \times 10^{-24}$ cm^2. (Figures in round brackets are experimental errors, those in square brackets are estimated uncertainties introduced by the theoretical evaluation.) Using these results, and the known B ($a\,^6S_{5/2}$) of ^{186}Re and ^{188}Re also, the nuclear quadrupole moments of these isotopes were derived: $Q(^{186}\text{Re}) \approx Q(^{188}\text{Re}) \approx 0.4 \times 10^{-24}$ cm^2. (auth)

3665 SCHUMANN–RUNGE EXCITATION BY PROTONS. Breene, R. G. Jr. (Physical Studies, Inc., Reno, Nev.). J. Chem. Phys., 45: 3876(Nov. 15, 1966).

Corrections to previous calculations of the cross section for Schumann–Runge excitation are reported. Corrected cross sections for proton energies from 5 to 50 keV are tabulated. (A.G.W.)

3666 DENSITY CHANGE ON VIBRATIONAL RELAXATION IN SHOCK-HEATED HYDROGEN AND DEUTERIUM. Kiefer, John H.; Lutz, Robert W. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 45: 3888-90(Nov. 15, 1966). (LA-DC-7974).

New and corrected measurements of the density change on relaxation in D_2 and H_2 and relaxation measurements on D_2 greatly enriched in the para modification are reported. The new values are larger than values reported earlier by a factor of 2. No detectable difference in behavior between normal D_2 and a mixture enriched in paradeuterium was found. This result suggests that pure ortho- and pure paradeuterium would exhibit the same relaxation time in the temperature range studied. (A.G.W.)

3667 STUDY OF INELASTIC COLLISIONS BY DRIFTING IONS. Kaneko, Y.; Megill, L. R.; Hasted, J. B. (London Univ.). J. Chem. Phys., 45: 3741-51(Nov. 15, 1966).

A series of experiments were performed in which a mass-analyzed ion beam is injected into a drift tube containing gas. The ions drift through the tube under the action of a uniform electric field and they undergo inelastic processes. The product ions are mass analyzed upon exit. The drift velocity and the ratio of the primary and secondary ion currents are measured as a function of the electric field and the gas pressure in the drift tube. From these data the cross section of the process is calculated. The effect of the lateral diffusion in the drift tube is discussed theoretically. Cross sections are determined in the energy range from 0.06 to 10 eV for the processes, $Ne^+ + Ar \rightarrow Ne + Ar^+$, $Ar^+ + Ne \rightarrow Ar + Ne^+$, $O^+ + N_2 \rightarrow O + N_2^+$, and $O^+ + O_2 \rightarrow O + O_2^+$. Because of the nature of the ion source used these processes are supposed to be conducted largely by the ions in their excited states. It is shown that the cross sections of the former two processes agree well with predictions based on the theory of Rapp and Francis if appropriate combinations of excited states are assumed. At the high-energy end, the cross sections of the latter two processes agree well with the results of the beam experiment of Stebbings et al. At the low-energy end, the cross section of the last process agrees well with experimental result of Fehsenfeld et al. at room temperature. A remarkable minimum is found in the last process. (auth)

3668 SYSTEMATIC USE OF SOLVENT EFFECTS IN HIGH-RESOLUTION NUCLEAR MAGNETIC RESONANCE. Freeman,

R.; Bhacca, N. S. (Varian Associates, Palo Alto, Calif.). J. Chem. Phys., 45: 3795-3805(Nov. 15, 1966).

It is shown that certain characteristic features of nuclear magnetic double-resonance spectra (the coalescence of spin multiplets or the splitting of single lines into doublets) can also be induced in single-resonance spectra of molecules that contain a pair of strongly coupled nuclei. Degeneracies due to overlap of two groups of resonance lines in one region of the spectrum may cause coalescence or splitting effects in some quite different region of the spectrum. These features are particularly easily recognizable when introduced into the spectrum in a gradual manner by the systematic use of preferential solvent shifts. Expressions derived for the transition frequencies and intensities bear a strong formal resemblance to those used for "spin-decoupling" and "spin-tickling" double-irradiation experiments. The strong temperature dependence of the chemical shift of the hydroxyl resonance in 2-propyn-1-ol has been exploited to induce the coalescence of certain lines in the spectrum of the methine proton, demonstrating that J(H−C−O−H) and J(H−C≡C−C−H) have opposite signs. This is a case where standard double-irradiation methods would not be applicable because the long-range coupling J(H−C≡C−C−O−H) is vanishingly small. Control over the overlap of the AB region of the ABMX spectrum of 3-fluoro-4-methoxyacetophenone makes it possible to induce splittings in the X spectrum, permitting the subspectra to be identified and the relative signs of the coupling constants to be obtained by inspection. The ortho and meta proton−fluorine coupling are shown to have the same sign, opposite to the sign of the para coupling. (auth)

3669 COLLECTIVE EXCITATIONS IN THE MANY-BOSON PROBLEM. Etters, R. D. (Iowa State Univ., Ames. Douglas Aircraft Co., Long Beach, Calif.). Nuovo Cimento (10), 44B: 68-90(July 11, 1966).

A theory for many-boson systems is developed from which the results of Feynman and those of Bogoliubov appear as special cases of a more general formalism. The criteria required to establish the validity of their separate calculations are also given. It is found that the results of the Bogoliubov approximation are valid under more general circumstances than was previously apparent. Furthermore, a temperature-dependent correction to the excitation spectrum is found which tends to increase the quasi-particle excitation energies. On the basis of this improved excitation spectrum, a successful interpretation is given for the recent experimental results of Woods on the temperature dependence for the excitation spectrum of HeI and HeII at low momenta. (auth)

3670 VIBRATIONAL AND CASCADE DISSOCIATION OF H_2^+ IONS BY COLLISIONS WITH MOLECULES OF A GAS. Valckx, F. P. G.; Verveer, P. (EURATOM-CEA, Fontenay-aux-Roses, France). J. Phys. (Paris), 27: 480-4(July-Aug. 1966). (In French).

Protons produced by collisional dissociation of H_2^+ ions have an energy spectrum with a narrow central peak. The protons in this peak are produced partly by vibrational dissociation and partly by a cascade from two collisions. For H_2^+ ions of 50 to 150 keV, the cross section for vibrational dissociation is about 4.1×10^{-18} cm^2/mol in hydrogen and 1.1×10^{-18} cm^2/mol in argon. (auth)

3671 THE ENERGY STRAGGLING OF 1-MeV PROTONS IN GASES. Mason, D. L.; Prior, R. M.; Quinton, A. R. (Univ. of Florida, Gainesville). Nucl. Instrum. Methods, 45: 41-4 (Nov.-Dec. 1966).

The energy straggling of 1-MeV protons in various gases was studied as a function of gas absorber thickness. The gases used were hydrogen, helium, nitrogen, nitrous oxide, oxygen, argon and xenon. For small energy losses, the observed straggling is in good agreement with the theories of Bohr and Lewis. However, large discrepancies appear when the energy loss is comparable to the initial energy of the protons. (auth)

3672 EXTENSION THEOREM AND THE CONSTRUCTION OF THE GENERATORS OF THE NONINVARIANCE GROUP FOR THE HYDROGEN ATOM. Sankaranarayanan, A. (Ames Lab., Ames, Iowa). Nuovo Cimento (10), 44B: 193-8(July 11, 1966). (IS-1340).

An investigation was made to construct the noninvariance group for the hydrogen-atom problem in n dimensions. The invariance and the noninvariance groups in this case are O_{n+1} and $O_{n+1,1}$, respectively, for the bound states and $O_{n,1}$ and $O_{n,2}$, respectively, for the continuum states; the so-called double-jump groups are not considered. (M.O.W.)

3673 ANOMALOUS ANGULAR DISTRIBUTION OF SCATTERED HEAVY IONS. Formann, E. (Univ., Vienna); Viehboeck, F. P.; Wotke, H. Phys. Lett., 23: 558-9(Nov. 28, 1966).

In the angular distribution of the backscattered particles two remarkable deviations from the quasi cosine distribution were observed. (auth)

3674 MINIMUM DIPOLE MOMENT REQUIRED TO BIND AN ELECTRON TO A FINITE DIPOLE. Turner, J. E. (Oak Ridge National Lab., Tenn.); Fox, K. Phys. Lett., 23: 547-9(Nov. 28, 1966).

The minimum dipole moment, $D_{min} = 0.6393\ ea_0 = 1.625 \times 10^{-18}$ esu-cm, required for electronic binding to a dipole has been found, weaker dipoles having no negative energy states. (auth)

3675 MINIMUM MOMENT REQUIRED TO BIND A CHARGED PARTICLE TO AN EXTENDED DIPOLE. Mittleman, M. H.; Myerscough, V. P. (Univ. of California, Berkeley). Phys. Lett., 23: 545-6(Nov. 28, 1966).

The problem of the minimum dipole moment of a finite dipole which will bind a charged particle is solved. First it is shown that such a value exists, and then a numerical solution is obtained using a previously published result. An approximate result is also given. (auth)

3676 BORN–OPPENHEIMER SEPARATION FOR THREE-PARTICLE SYSTEMS. I. THEORY. Hunter, G.; Gray, B. F.; Pritchard, H. O. (Univ. of Manchester, Eng.). J. Chem. Phys., 45: 3806-16(Nov. 15, 1966).

The Born−Oppenheimer separation for a three-particle system was re-examined in detail using a variational approach including a scale parameter. Discrepancies arising in earlier work were resolved. Tables of adiabatic and nonadiabatic coupling terms are presented. (auth)

3677 VIBRATION SPECTRA OF YTTRIUM AND URANIUM HYDRIDES BY THE INELASTIC SCATTERING OF COLD NEUTRONS. Rush, J. J. (Argonne National Lab., Ill. Inst. for Materials Research, National Bureau of Standards, Washington, D. C.); Flotow, H. E.; Connor, D. W.; Thaper, C. L. J. Chem. Phys., 45: 3817-25(Nov. 15, 1966).

The vibration spectra of the hydrides and deuterides of yttrium and uranium were investigated by the energy-gain scattering of cold neutrons. The measured spectra are all split into two bands, one at higher energies due to the optical hydrogen vibrations and another at lower energies due to metal−atom vibrations. Values have been obtained for the peaks and widths of the single optical hydrogen bands in YH_2, YD_2, UH_3, and UD_3 by the calculation of approximate frequency distributions from the observed neutron time-of-flight spectra. The derived peak frequencies in cm^{-1} are: YH_2, 1025 ± 60; YD_2, 725 ± 40; UH_3, 970 ± 60; UD_3, 710 ± 40. The relative width at half-maximum for the hydrogen band in UH_3 is about double that for YH_2. The distribution of hydrogen vibrations in hexagonal YH_3 and YD_3 is considerably broader, and exhibits several maxima, due to hydrogens at different sites in the lattice. The hydrogen modes in all the compounds can be correlated reasonably well with the known crystal structures. The results are in satisfactory agreement with hydrogen frequencies calculated previously from heat-capacity data. (auth)

3678 EXOTHERMIC ION–MOLECULE REACTIONS. Moran, T. F.; Friedman, L. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. J. Chem. Phys., 45: 3837-45(Nov. 15, 1966). (BNL-10368).

Dissociative charge-transfer reactions between rare-gas He^+, Ne^+ ions and diatomic N_2, O_2, CO, NO molecules were studied as a function of reactant-ion velocity. N^+, O^+, and C^+ fragment ions are the major reaction products observed in these exothermic reactions. Experimental cross sections and corresponding rate constants for thermal-energy ions are in semiquantitative agreement with the theoretical rates calculated from the long-range ion-induced-dipole potential. A reversed-repeller technique was used to probe the kinetic-energy distributions of the ionic reaction products and the experimental (0.2 to 1 eV) distributions so obtained are well correlated with the heats of the respective reactions. The kinetic energies of the product N^+ and O^+ ions were shifted to lower values when $^3He^+$ was substituted for $^4He^+$ ions in the NO and O_2 reactions. This shift in product-ion kinetic energy rules out accidentally resonant charge-transfer processes involving excited product atoms and is consistent with a two-body breakup mechanism of transitory HeN^+ at low reactant-ion velocities. (auth)

3679 NUCLEAR MAGNETIC DOUBLE RESONANCE WITH AN INCOHERENT RADIO-FREQUENCY FIELD. Ernst, R. R. (Varian Associates, Palo Alto, Calif.). J. Chem. Phys., 45: 3845-61(Nov. 15, 1966).

The decoupling of heteronuclear spin systems by means of a strong irradiation of rf magnetic random noise is explored theoretically and experimentally. It is shown that it is feasible to eliminate simultaneously all splittings due to one or more nuclear

species. Double resonance with random noise is of particular advantage if the resonance frequencies of the nuclei causing the splittings cover a wide spectral range and if, at the same time, the couplings are relatively weak. In the case of a narrow spectral range and strong couplings, double resonance with a coherently frequency-modulated rf field can give comparable decoupling effects. Double resonance with random noise has a strong similarity to the effects of chemical exchange and relaxation. (auth)

3680 VIBRATIONAL RELAXATION TIMES OF DEUTERIUM AND HYDROGEN. A COMPARISON OF THEORY AND EXPERIMENT. Parker, J. G. (Johns Hopkins Univ., Silver Spring, Md.). Contract NOw-62-0604-c. J. Chem. Phys., 45: 3641-5 (Nov. 15, 1966).

A comparison of experimental and theoretical vibrational collision numbers was carried out for deuterium and hydrogen and also for interactions of those gases with argon and krypton. Agreement is obtained for the latter while definite discrepancies appear for the D_2-D_2 and H_2-H_2 interactions. This discrepancy is rather large at the lowest temperatures; however, extrapolation of the experimental data indicates that at temperatures of the order of 10,000°K agreement is attained. The intermolecular interaction constants used in comparing theory and experiment are shown to be consistent with those derived from measurements on rotational relaxation times for hydrogen and hydrogen–rare-gas mixtures. From these interaction constants a value of 67 collisions is obtained for the rotational collision number of hydrogen in the limit of very high temperature. (auth)

3681 LONG-RANGE SCATTERING FROM ANISOTROPIC POTENTIALS: DIPOLE–DIPOLE SCATTERING. Cross, R. J. Jr.; Gordon, R. G. (Harvard Univ., Cambridge, Mass.). J. Chem. Phys., 45: 3571-82(Nov. 15, 1966).

Total cross sections were calculated for collisions of polar molecules. They were found to be determined chiefly by the rotationally inelastic collisions occurring at large impact parameters and to be highly sensitive to the amount of energy transferred from translation to rotation. The calculations were done by using either the Born approximation or a semiclassical method based on time-dependent perturbation theory to obtain the scattering matrix for large impact parameters (both methods yield the same results). Scattering at smaller impact parameters was handled using a generalized Massey–Mohr treatment. The cross sections were found to be large and strongly dependent on the rotational states. Averaged cross sections were calculated for Boltzmann distributions of rotational states. These depend, as expected, on both the rotation constants and on the rotational temperature. Cross sections for linear dipoles such as alkali halides scattered by CH_3I are around 4000 Å^2. Cross sections for two symmetric tops are much higher. The averaged velocity derivative is quite different from that found for atom–atom scattering. A calculation of the second-order elastic scattering was done for the case where the rotational energy levels of the two molecules are badly mismatched. Comparison is made with several other treatments which use the sudden approximation or some sort of averaged potential. The methods developed are also applicable to scattering of polarized beams or to the calculation of small-angle inelastic scattering. (auth)

3682 DIPOLE–DIPOLE SCATTERING IN MOLECULAR BEAMS. VARIATION OF TOTAL CROSS SECTION WITH VELOCITY AND ROTATIONAL OVERLAP. Cross, R. J. Jr.; Gislason, E. A.; Herschbach, D. R. (Harvard Univ., Cambridge, Mass.). J. Chem. Phys., 45: 3582-93(Nov. 15, 1966).

Total cross sections were measured for scattering of velocity-selected beams of alkali halide molecules KCl, CsCl, and CsBr by HBr and CH_3I and, for comparison, for Kr and Xe. The pressure in the scattering chamber was monitored by a second crossed beam of alkali atoms, which allowed direct measurement of the ratios of cross sections for different molecules interacting with the same scattering gas. As expected from the first-order selection rules, the results indicate that the contribution of rotationally inelastic transitions produced by the angle-dependent dipole–dipole force depends strongly on the extent to which the rotational spectra of the two molecules overlap. Inelastic scattering appears to be dominant for the CH_3I systems, where the overlap is very good. The cross sections are ~5000 Å^2 (compared with ~1400 Å^2 for elastic van der Waals scattering; both corrected for angular resolution) and the velocity dependence is much weaker than for elastic scattering. In the appendix simple approximate formulas are derived from which the first-order inelastic dipole–dipole cross section can be calculated without numerical integrations over impact parameters and rotational distributions. (auth)

3683 COLLISION FREQUENCIES AND ENERGY TRANSFER: IONS. Banks, Peter (Institut d'Aeronomie Spatiale de Belgique, Brussels. Pennsylvania State Univ., University Park). Planet. Space Sci., 14: 1105-22(Nov. 1966).

An investigation was made of ion collision frequencies and energy transfer for conditions of gaseous thermal nonequilibrium. Following the methods of a development devoted to electron collisions, the problems of ion–neutral and ion–ion elastic collisions have been considered under the assumption of separate Maxwellian velocity distributions. Expressions for the nonequilibrium momentum transfer cross sections, collision frequencies, and energy transfer rates are given for neutral gases on the basis of a polarization potential and for ions on the basis of the Coulomb interaction. Next, the problem of ion–neutral resonance charge exchange is introduced in its effect upon collision cross sections and ion energy transfer rates. An analysis is made of gathered laboratory data to arrive at suitable expressions for the resonance charge exchange and momentum transfer cross sections for H^+, O^+, He^+, N_2^+, and O_2^+. Using these results, resonance charge exchange and momentum transfer collision frequencies are derived. The resonance ion–neutral energy transfer rates are then presented and compared with expressions used in previous studies of ion temperatures. (auth)

3684 CROSS SECTION OF ELECTRON CAPTURE BY SPHERICAL PARTICLES AND THERMAL IONIZATION PARTICLES. Samuilov, E. V. Teplofiz. Vysok. Temp., 4: 143-7 (Mar.-Apr. 1966). (In Russian).

Cross sections of electron capture by spherical charged and neutron particles were calculated considering the Debye screening of the coulomb and "image" forces. The active mass law was developed for the quasistationary case of particle ionization at various gas, particle, and electron temperatures. Computations assumed that the particle radius was considerably smaller than the mean distance between electrons. (tr-auth)

3685 CALCULATION OF THE EFFECTIVE CROSS SECTIONS FOR PROTON CHARGE EXCHANGE IN COLLISIONS WITH MULTIELECTRON ATOMS. Nikolaev, V. S. (Moscow State Univ.). Zh. Eksp. Teoret. Fiz., 51: 1263-80(Oct. 1966). (In Russian).

The charge exchange effective cross sections for fast protons in Ar, H, He, Kr, Li, N, and Ne are calculated in the one-electron variant of the Brinkman–Kramers approximation using hydrogen-like wave functions. A simple generalization of the Brinkman–Cramers formula is obtained for arbitrary values of the external and internal screening parameters. It was found possible to represent the ratio of experimental cross sections to calculated ones by a single parameter function which is valid for all media with an accuracy of 20 to 25%. This function is employed for determining the proton charge exchange cross section in the indicated media at energies between 20 keV and 13 MeV. The procedure is proposed as a semi-empirical method for calculating the charge exchange cross sections of protons colliding with atoms or simple molecules. The latest experimental data on cross sections for electron capture into highly excited hydrogen atom states are discussed. (auth)

3686 SCATTERING OF HIGHLY EXCITED ARGON ATOMS ON HYDROGEN AND THE FORMATION OF ArH^+ IONS. Kupriyanov, S. E. (Inst. of Physics, Academy of Sciences, USSR). Zh. Eksp. Teoret. Fiz., 51: 111-13(Oct. 1966).

Scattering of highly excited argon atoms on hydrogen is studied in a mass spectrometer with a double-chamber ion source. The total scattering cross section is $\geq 4 \times 10^{-14}$ cm^2/molecule. It is shown that ArH^+ ion formation occurs during encounters between highly excited argon atoms and hydrogen molecules. (auth)

3687 SLOW ION FORMATION DUE TO PASSAGE OF FAST PROTONS AND HYDROGEN ATOMS THROUGH NITROUS OXIDE. Gusev, V. A.; Pilipenko, D. V.; Fogel, Ya. M. (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Zh. Eksp. Teoret. Fiz., 51: 1007-10(Oct. 1966).

An investigation is made of the mass spectra of slow positive ions produced as a result of dissociative ionization of N_2O molecules by fast protons or hydrogen atoms and also of the mass spectra of slow negative ions produced as a result of charge exchange between the hydrogen atom and N_2O molecule. The relative intensities of the slow ion beams are compared with the bond breaking energies of N_2O. (auth)

3688 COLLISION-INDUCED DISSOCIATION OF D_2^+ IONS BY ARGON AND NITROGEN. Champion, R. L.; Doverspike, L. D.; Bailey, T. L. (Univ. of Florida, Gainesville). J. Chem. Phys., 45: 4377-84(Dec. 15, 1966).

The reactions $D_2^+ + X \rightarrow D^+ + D + X$, where X is Ar or N_2, have been studied with an angular ion-scattering apparatus at ion laboratory energies in the range 5 to 120 eV. Kinetic-energy distributions as well as angular distributions of the product D^+ ions have been determined. The experimental method consists of directing a well-collimated, mass-analyzed, and energy-selected

ion beam into a scattering region and analyzing the product ions with a 127° electrostatic velocity selector and a radiofrequency mass filter. The product ion analysis and detection system rotates about the center of the scattering region. The results are discussed in terms of a simple two-step collision model, where the D_2^+ ion is first excited electronically to the antibonding $^2\Sigma_u$ state, and then dissociates. The possibility of direct excitation of the D_2^+ ion into the vibrational continuum is also discussed. If either model is assumed for the reaction, the experimental results indicate that the most probable reaction channel for the collision-induced dissociation reaction is one in which primary D_2^+ ions with large vibrational energies give rise to D and D^+ products, which separate with small relative velocities. These results are consistent with some existing opinion that the collision-induced dissociation cross section increases rapidly as the vibrational excitation of the primary ion is increased. (auth)

3689 ENERGETIC AND ANGULAR STUDIES OF ArD^+ AND N_2D^+ FORMATION. Doverspike, L. D.; Champion, R. L.; Bailey, T. L. (Univ. of Florida, Gainesville). J. Chem. Phys., 45: 4385-91(Dec. 15, 1966).

The reactions $Ar^+ + D_2 \rightarrow ArD^+ + D$ and $N_2^+ + D_2 \rightarrow N_2D^+ + D$ have been studied with an angular ion-scattering apparatus at ion laboratory energies in the range 2 to 100 eV. Kinetic-energy distributions as well as angular distributions of the product ions have been determined. The experimental method consists of directing a mass-analyzed and velocity-selected ion beam into a collision chamber containing target gas at low pressure. The product ions are velocity analyzed with a 127° electrostatic velocity selector and mass analyzed in a quadrupole field radio-frequency mass filter. The product-ion analysis and detection system rotates about the center of the scattering region. It is found that the observed Q values for these reactions (where Q is the energy transformed from internal to translational) show a marked dependence on the primary-ion kinetic energy, E_1. The Q values for both reactions are endothermic over the entire energy range of these experiments, being approximately zero at the lowest energies and exhibiting endothermic maxima in the region $50 < E_1 < 60$ eV. It is shown that these maxima correspond to the formation of internally excited product ArD^+ and N_2D^+ ions, with excitation energies approximately equal to the dissociation energies for $ArD^+ \rightarrow Ar + D^+$ and $N_2D^+ \rightarrow N_2 + D^+$. The production kinetic-energy distributions also give evidence of back scattering in the center-of-mass system. The energetic and angular features of both reactions are essentially the same, indicating that the collision mechanisms leading to the formation of both product ions do not differ significantly. The experimental results indicate that both reactions proceed according to a pickup mechanism at moderate collision energies. At very low collision energies the results suggest that complex formation may become important. (auth)

3690 SURVEY OF NEGATIVE-ION–MOLECULE REACTIONS IN O_2, CO_2, H_2O, CO, AND MIXTURES OF THESE GASES AT HIGH PRESSURES. Moruzzi, J. L.; Phelps, A. V. (Westinghouse Research Labs., Pittsburgh). J. Chem. Phys., 45: 4617-27 (Dec. 15, 1966).

The negative-ion species produced in O_2 and some gases containing oxygen have been surveyed for various pressure and E/p conditions using an rf mass spectrometer coupled to an electron drift tube operating at pressures up to 5 torr. The gases studied include O_2, CO_2, H_2O, and CO as well as the mixtures CO_2-O_2, H_2O-O_2, $CO-O_2$ at moderate and high E/p. When CO_2 is present, O_2^- and O^- are converted to CO_4^- and CO_3^-, respectively. The rate coefficients for these reactions at 300°K are approximately 1.3×10^{-29} and 8×10^{-29} cm^3/sec, respectively. When H_2O is present complex ions such as $(H_2O)_n \cdot O_2^-$, $(H_2O)_n \cdot O^-$ and $(H_2O)_n \cdot OH^-$ are formed with $n \leq 5$. In $CO-O_2$ and H_2-O_2 mixtures, ion destruction, consistent with associative detachment of O^-, has been observed to proceed with rate coefficients of about 10^{-9} cm^3/sec. (auth)

3691 NONDISSOCIATIVE ELECTRON CAPTURE IN COMPLEX MOLECULES AND NEGATIVE-ION LIFETIMES. Compton, R. N.; Christophorou, L. G.; Hurst, G. S.; Reinhardt, P. W. (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 45: 4634-9 (Dec. 15, 1966).

The formation and decay of parent negative ions have been studied with electron-swarm and electron-beam techniques. The rate of attachment at thermal energies under electron-swarm conditions for SF_6 and $C_6H_5NO_2$ was determined to be 1.24×10^9 and 2.1×10^7 sec^{-1} $torr^{-1}$, respectively. Autoionization lifetimes for SF_6^-, $C_6H_5NO_2^-$, and $(CH_3CO)_2^-$ are reported to be 25, 40, and 12 μsec, respectively. The absolute rate of electron attachment in SF_6 was found to be independent of the temperature ($298° \leq T \leq 418$°K), and is thus consistent with an electron-capture cross section for SF_6 that varies inversely with the speed of the electron. The attachment rates and lifetimes were combined through the principle of detailed balance to calculate the ratio of density of states of the negative ion to that of the neutral plus electron. A simple theoretical treatment of long-lived negative ions is presented, and the possibility of estimating electron affinities from measurements of attachment cross sections and negative-ion lifetimes is pointed out. (auth)

3692 INELASTIC ENERGY TRANSFER COLLISIONS BETWEEN ATOMS. Ermisch, Wolfgang (Humboldt-Univ., Berlin). Beitr. Plasmaphys., 6: 73-88(1966). (In German).

A review is given of the theoretical and experimental studies on inelastic energy transfer collisions between atoms. The methods for the theoretical determination of the effective cross section are given. The experimental results from quenching collisions, sensitized fluorescence, and the polarizing collisions are compared with theory. (J.S.R.)

3693 MEASUREMENT OF THE EFFECTIVE DIFFERENTIAL ELASTIC CROSS SECTIONS FOR ELECTRON SCATTERING ON FREE SILVER ATOMS. Fink, M.; Kessler, J. (Technische Hochschule, Karlsruhe, Ger.). Z. Phys., 196: 504-7(1966). (In German).

Measurements of the elastic small-angle scattering cross sections of silver for 60 keV electrons which were performed with silver-atom beams are given. The results agree with the theoretical values of Ibers and Vainshtein. Comparison of the experimental results with the earlier measurements of the cross sections made with silver films shows no agreement at all. So the conjecture of several authors that the great differences between the theoretical small-angle scattering cross sections and those measured in foils are due to differences of the cross sections between isolated and condensed atoms could be verified. (auth)

3694 INDUCED BREMSSTRAHLUNG EFFECT IN THE RELATIVISTIC REGION. Fedorov, M. V. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 51: 795-803(Sept. 1966). (In Russian).

The induced bremsstrahlung effect on relativistic electrons is considered. An expression for the cross section for stimulated emission from a photon is derived for the case of scattering on isolated ions. Its asymptotic form for high energies is derived. The case of electron scattering in a crystal is also considered. The conditions for negative absorption are derived and numerical estimates are presented. It is demonstrated that, in principle, an electromagnetic wave amplification factor $\alpha \sim 3 \cdot 10^2$ cm^{-1} can be obtained for narrow beams of ultrafast electrons ($\Delta\varphi \lesssim |10^{-5}$, $\epsilon > 10^2$ mc^2) scattered in a crystal. (auth)

3695 INDUCED COMBINATIONAL SCATTERING IN ANISOTROPIC MEDIA. Lugovoi, V. N. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 51: 931-5(Sept. 1966). (In Russian).

Induced combinational scattering in crystals is considered. It is shown that each scattering component (besides the first Stokes component) consists of a fundamental and supplementary radiation. Both radiations propagate at definite (but different) angles with respect to the direction of the incident wave. The supplementary radiation is due to interaction of various types of waves in the crystal and can be observed only in a certain range of orientations of the crystal relative to the direction of the incident wave. Equations are deduced which define the angles of emission of the induced combinational scattering components, and the corresponding angular widths are estimated. (auth)

3696 DIVERSION OF ATOMIC BEAMS IN LONG CYLINDRICAL DEFLECTION SYSTEMS CONSIDERING VELOCITY DISTRIBUTIONS. Becker, G.; Fischer, B. (Physikalisch-Technische Bundesanstalt, Brunswick). Z. Angew. Phys., 21: 492-9 (1966). (In German).

The focusing qualities of long cylindrical deflection systems for atomic beams, consisting of atoms with positive or negative dipole moments, are theoretically investigated taking into account the velocity distribution in the beam. For atomic resonance techniques the efficiency η of the deflection systems with respect to the separation of atoms with different energies is of great importance. By means of graphical integration the received solution for η was evaluated for the case of a typical beam geometry of the hydrogen maser. Further on, two approximation theories, assuming small target diameters, were developed resulting in analytic expressions for η which are easy to evaluate. (auth)

3697 THE PRESSURE-INDUCED MONOCHROMATIC TRANSLATIONAL ABSORPTION COEFFICIENTS FOR HOMOPOLAR AND NON-POLAR GASES AND GAS MIXTURES WITH PARTICULAR APPLICATION TO H_2. Trafton, L. M. (California Inst. of Tech., Pasadena). Astrophys. J., 146: 558-71 (Nov. 1966).

Published work on the integrated translational absorption coefficient of homopolar and nonpolar gases is extended to obtain the frequency dependence for the case where the exchange forces are negligible. Expressions are derived for the pressure-induced monochromatic binary absorption coefficients for a homopolar diatomic gas, mixtures of a homopolar diatomic gas and a nonpolar monatomic gas, and mixtures of nonpolar monatomic gases. The cases considered are those for which quadrupolar induction and overlap forces are both responsible for inducing the dipole moment. The intermolecular forces are assumed to be isotropic. The expressions are evaluated numerically for the case of H_2 using the Lennard–Jones model for the intermolecular potential. The matrix elements were computed numerically by means of a high-speed electronic computer and are tabulated to allow calculation of the translational profile for H_2 at arbitrary temperatures. The results at 100, 300, and 600°K are presented graphically and the results at 77°K are compared with a published experimental profile in the region from 80 to 180 cm^{-1}. (auth)

3698 EXACT VIBRATIONAL MATRIX ELEMENTS FOR MOLECULAR HYDROGEN AND THE INTENSITY OF THE QUADRUPOLE ROTATION–VIBRATION SPECTRUM. James, Thomas C. (National Bureau of Standards, Washington, D. C.). Astrophys. J., 146: 572-80(Nov. 1966).

Accurate vibrational overlap integrals and matrix elements of $\xi = (r-r_e)/r_e$, ξ^2, and ξ^3 were calculated for lines in the 1-0, 2-0, 3-0, and 4-0 rotation–vibration bands of molecular hydrogen. The effect of rotation–vibration interaction was found to be significant, and values of the matrix elements of ξ and its powers are given for Q-, S-, and some O-branch lines. The calculations were carried out numerically using an RKR potential for H_2 from which the vibrational wave functions were determined by solving the radial Schrödinger equation. These results are used to analyze the intensity measurements, reported by Rank and associates for the H_2 quadrupole rotation–vibration spectrum. The possibility of predicting the intensity of the 4–0 band, and of using the 2–0, and 3–0 bands for rotational temperature measurements is discussed. (auth)

3699 STUDY OF NONRELATIVISTIC ELECTRONS IN THIN METALLIC FILMS. Arutyunyan, F. R.; Petrosyan, Zh. V.; Oganesyan, R. A. (Joint Radiation Labs., Academy of Sciences, Armenian SSR, Erevan State Univ.). Zh. Eksp. Teor. Fiz., 51: 760-72(Sept. 1966). (In Russian).

Optical radiation (λ = 3480 to 5500 Å) produced by 60-keV electrons traversing thin (d = 200 to 1340 Å) silver and gold films is investigated experimentally. The spectral and angular distributions of the radiation and also the dependence of its intensity on electron energy and film thickness are investigated for photons polarized in a plane containing the normal to the film surface and the direction of observation (emission plane) as well as in the perpendicular plane. The properties of the light polarized in the emission plane are in complete accordance with the Ginzburg–Frank theory of transition radiation. Light polarized in the perpendicular plane is identified as bremsstrahlung radiation. Polarization of the radiation is also analyzed. (auth)

Cosmic Radiation

Refer also to abstracts 3179 and 3592.

3700 (CONF-651216) PROCEEDINGS OF THE NINTH SYMPOSIUM ON COSMIC RAYS, ELEMENTARY PARTICLE PHYSICS AND ASTROPHYSICS, HELD IN BOMBAY, DECEMBER 13–17, 1965. (Department of Atomic Energy, Bombay (India)). 834p. Dep. mn.

Eighty-five papers are presented on cosmic radiation, elementary particles, and astrophysics. Separate abstracts were prepared for sixty-five of the papers. Twenty of the papers were previously abstracted. (W.D.M.)

For abstracts of individual papers see: 3252, 3565–3573, 3707–3730, 3972, 3979–3983, 3989–3994, 4004, 4014, 4047–4049, 4060, 4061, 4072, 4073, 4091, 4096, 4192, 4193, 4206–4208, and 4239–4241.

3701 (N-66-29451) EXPERIMENTS IN X-RAY AND GAMMA-RAY ASTRONOMY. Peterson, Laurence E. (California Univ., La Jolla, San Diego. Dept. of Physics). [1965]. Contracts NAS5-3122; NAS5-3177; NASw-56. 28p. (NASA-CR-64398). CFSTI $3.00 cy, $0.65 mn.

To study cosmic photons in the general range of 10 keV to 5 MeV, satellite-borne instruments, and an Orbiting Solar Observatory (OSO) and radiation detectors were used for astronomical observation and measurements. Preliminary balloon investigations, conducted to plan and design experiments for cosmic photon measurements in this general energy range and to interpret OSO results, culminated in the development of an x-ray detector. A functional diagram of an exploratory experiment in gamma-ray astronomy is presented, and the rates of the isotropic gamma-ray detectors on the OSO-1, as a function of geographic latitude, are given. The upper limits of the search for cosmic fluxes from the OSO-1 compared with other measurements are shown graphically. The differential spectrum of measured cosmic x-ray fluxes is also included. (STAR)

3702 (N-66-29456) NATURE OF THE SPACE ENVIRONMENT. Evvard, John C. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). [1965]. 37p. (NASA-TM-X-56741). CFSTI $3.00 cy, $0.65 mn.

The phenomena of solar space and the solar system are examined in relation to the probabilities of cosmic rays, solar winds, lethal radiations associated with solar flares, and the occurrence of magnetic storms. Equations for estimating the atmospheric composition are derived, and the variations in composition with altitude are discussed. The dependence of radio transmission on sky wave refraction is assessed, and the use of passive and active communication satellites as communication system links is explored. The origin of airglow is related to the view the astronauts see from the orbiting spacecraft, and the necessary illumination criteria for visual observation of earth are defined. Factors governing the thermal environment, and the effects of the magnetic field on the near-earth space environment are delineated. Satellite data on the Van Allen belts are presented, and the problems connected with meteoroid flux and penetration are considered. Planetary environments for manned exploration are also discussed. (STAR)

3703 (N-66-29968) SOLAR MODULATION OF GALACTIC COSMIC RAYS. Balasubrahmanyan, V. K.; Boldt, E.; Palmeira, R. A. R. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). May 1966. 38p. (NASA-TM-55500; X-611-66-226). CFSTI $3.00 cy, $0.65 mn.

The modulation of galactic protons and He nuclei during the last solar cycle is analyzed according to Parker's theory. The mechanism of modulation remains essentially the same during several years of low solar activity (1961–1965). The modulation near solar maximum (1959) implies that the scale sizes of the magnetic inhomogeneities in the solar wind are reduced below the values at solar minimum. An adequate description at solar maximum would require further refinements of the theory. The proton to He nucleus ratio outside the solar system is shown to be consistent with a value ≈6, in a kinetic energy/nucleon representation for the interval 50 to 1000 MeV/nucleon. (auth)

3704 COSMIC-RAY ELECTRON SPECTRUM AND THE UNIVERSAL BLACKBODY RADIATION AT 3 DEG K. O'Connell, R. F. (Goddard Space Flight Center, New York). Phys. Rev. Lett., 17: 1232-4(Dec. 12, 1966).

It is shown that the observed energy spectrum of cosmic-ray electrons between 1 and 350 GeV may be compatible with the existence of a universal blackbody radiation at 3°K, in contrast to a conclusion reported by Daniel and Stephens. (auth)

3705 NECESSITY OF A NEW HYPOTHESIS REGARDING ENERGY TRANSFER TO AN ELECTRON–PHOTON CASCADE BY NUCLEONS WITH ENERGIES EXCEEDING 10^{13} eV. Nikolskii, S. I. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 51: 804-18(Sept. 1966). (In Russian).

Results of calculations and the experimental data on the extensive air shower distribution in respect to number of electrons and muons and on the energy spectrum of nuclear-active particles, on the spectrum of showers accompanying high energy nuclear-active particles and on the shower composition are compared. It is shown that in order to explain the totality of experimental data relating to ultra high energy cosmic rays one is forced to assume the existence of an additional mechanism for energy transfer from nucleons with energies above 4×10^{13} eV to the electron-photon component. Concurrent with the appearance of the new process the primary cosmic ray spectrum changes at the same energy. (auth)

3706 COSMIC-RAY PROPAGATION. I. CHARGED PARTICLES IN A RANDOM MAGNETIC FIELD. Jokipii, J. R. (Univ. of Chicago). Astrophys. J., 146: 480-7(Nov. 1966).

A description of charged-particle motion in an irregular magnetic field is obtained. The magnetic field is taken to be the superposition of a constant field $B_0\hat{e}_z$ and a smaller fluctuating component B_1 which is a homogeneous random function of position with zero mean. The Fokker–Planck coefficients, describing the evolution of the particle distribution in pitch angle and position, are derived explicitly in terms of the two-point correlation function of B_1, or, alternatively, in terms of the Fourier spectrum of the irregular field. The time evolution of the distribution is found to depend on the irregular field in two ways: (1) A particle is scattered by those irregularities which are seen by the particle to be

in resonance with its cyclotron frequency. (2) A particle follows the random walk of a field line in the X, Y plane as it moves along the Z axis. The diffusion limit of the Fokker–Planck equation, suppressing the pitch-angle dependence, is then considered and a diffusion tensor is derived. The application to spacecraft magnetic field observations is discussed, and the Fokker–Planck coefficients are related to the observed power spectrum of interplanetary magnetic-field fluctuations. (auth)

3707 COSMIC X RAYS, GAMMA RAYS, AND ELECTRONS. Daniel, R. R. (Tata Inst. of Fundamental Research, Bombay). pp 10-25 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

A general review is presented on cosmic X rays, γ rays, and electrons. The various processes that can give rise to these radiations under astrophysical conditions are considered. The detection and measurement of the radiations are discussed at some length. (W.D.M.)

3708 PRODUCTION OF ELECTRONS IN INTERSTELLAR SPACE. Vijayalakshmi, B. (Tata Inst. of Fundamental Research, Bombay). pp 44-53 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

The spectrum of electrons arising from the $\pi-\mu-e$ decay of the pions produced in collisions of primary cosmic-ray nuclei with interstellar matter is computed. The energy spectrum of electrons and positrons from this source, at the top of the Earth's atmosphere is then calculated by applying suitable energy losses in interstellar space and solar modulation factors. By a comparison of the spectrum thus obtained and the spectrum of electrons observed experimentally, the spectrum of electrons accelerated directly at the source is calculated. The positron-to-electron ratio is determined as a function of energy and the various factors that can affect this ratio are discussed. (auth)

3709 ISOTOPIC COMPOSITION OF HELIUM NUCLEI IN THE PRIMARY COSMIC RAYS. Biswas, S.; Lavakare, P. J.; Ramadurai, S.; Sreenivasan, N. (Tata Inst. of Fundamental Research, Bombay). pp 77-83 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

The determination of isotopic composition of helium nuclei in primary cosmic rays yield twofold informations. (i) If it is assumed that ^3He is nearly absent in the sources of cosmic rays, then a determination of the ratio $^3He/(^3He + ^4He)$ will give an estimate of the amount of matter traversed by cosmic rays. (ii) The charge-to-mass ratio of the two isotopes being different it is hoped, at least in principle, to arrive at certain meaningful conclusions about the propagation characteristics of cosmic rays in interstellar and interplanetary space. With these aims in mind a nuclear emulsion stack consisting of insensitive emulsions was flown over Fort Churchill in June, 1963. Experimental details are given and it is concluded that the solar modulation does not affect the ratio. (auth)

3710 THE RATIO $^3He/(^3He + ^4He)$ IN PRIMARY COSMIC RADIATION AT HIGH RIGIDITIES. Apparao, M. V. K. (Tata Inst. of Fundamental Research, Bombay). pp 94-7 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

The ratio of helium nuclei to the M nuclei (C, N, O, F) in primary cosmic radiation has been recently determined as a function of rigidity with considerable accuracy. The ratio, starting from a rigidity of 1.5 BV, decreases to a minimum at ~2.5 BV and rises again towards higher energies. Such a behavior has been interpreted as due to a difference in the slopes of the energy spectra of helium and M nuclei. An alternate possibility is considered, namely, the presence of ^3He nuclei. This is motivated by the high value of the ratio $^3He/(^3He + ^4He) = 0.54 \pm 0.26$ observed at a rigidity >16 BV. (W.D.M.)

3711 A STUDY OF HEAVY NUCLEI OF COSMIC RADIATION IN JUNE 1963 OVER FORT CHURCHILL. Bhatia, V. S.; Chohan, V. S.; Pabbi, S. D. (Panjab Univ., Chandigarh, India). pp 115-20 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

The composition and energy spectra of heavy nuclei ($Z \geq 3$) of the primary cosmic rays is under study. A stack of nuclear emulsions of different sensitivities exposed in June 1963 at 4.3 g/cm^2 of residual atmosphere over Fort Churchill, Canada, was examined. An analysis of 223 tracks of $Z \geq 3$ was done. Emphasis was placed on the assignment of individual charges and the determination of fluxes and L/S ratios at the top of the atmosphere. These L/S ratios for nuclei of ≤600 MeV/n and >600 MeV/n are 0.31 ± 0.10 and 0.18 ± 0.05, respectively. From these values the amount of interstellar matter traversed by cosmic rays comes out to be (4.5 ± 1.5) g/cm^2 and (2.7 ± 0.8) g/cm^2, respectively. It thus appears that the amount of interstellar matter traversed by low-energy heavy primaries is greater than that for primaries of high energy. (auth)

3712 COMPOSITION OF THE SOURCE OF COSMIC RAYS. Apparao, M. V. K.; Ramadurai, S. (Tata Inst. of Fundamental Research, Bombay). pp 127-34 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

Assuming certain composition for cosmic-ray sources the relative abundances of the cosmic-ray nuclei at the earth are obtained, taking into account the effect of ionization and spallation losses during their propagation in interstellar space. Since these ratios are independent of solar modulation they are compared with the ratios obtained for the various charge groups by experiments at the earth. From this comparison conclusions are drawn about the composition of the sources. The composition so obtained is compared with the composition of various astronomical objects determined by other means. (auth)

3713 COSMIC RAY CHARGED PARTICLES AND PHOTONS IN THE ATMOSPHERE. Kasturirangan, K. (Physical Research Lab., Ahmedabad, India). pp 143-51 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

A detector unit consisting of seven G–M counters in a ring geometry was flown by a polyethylene balloon of volume 1.21×10^3 m^3 from Ahmedabad. The balloon attained an altitude of 78,000 ft, corresponding to 31 mb. The detector system and electronics functioned satisfactorily. Fluxes of the charged and photonic component of cosmic rays in the atmosphere were obtained separately. The data were transmitted to the ground by fm/fm telemetry. (auth)

3714 EAST-WEST AND NORTH-SOUTH ASYMMETRIES OF PRIMARY COSMIC RADIATION. Gokhale, G. S.; Kunte, P. K.; Sunderrajan, R. (Tata Inst. of Fundamental Research, Bombay). pp 152-7 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

The east–west and north–south asymmetries over Hyderabad, 8°N, determined by an oriented double telescope instrument, are presented. The implications of the results on the geomagnetic theory are discussed. (auth)

3715 COSMIC RAY MODULATION. Rao, U. R. (Physical Research Lab., Ahmedabad, India). pp 158-77 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

Many mechanisms have been proposed to explain cosmic-ray modulation but, as yet, no really satisfactory theory exists to describe the processes. The important effects can be broadly categorized into two classes: (a) Isotropic and time-dependent variations and (b) anisotropic changes. A discussion is presented on anisotropies which include the daily variation of cosmic-ray intensity and initial anisotropies observed during solar flare increases and Forbush decreases. A few space probe and satellite experiments that are currently under construction to study the anisotropic changes of intensity are briefly considered. (W.D.M.)

3716 CURRENT THEORIES OF INTERPLANETARY MODULATION OF GALACTIC COSMIC RAYS. Subramanian, G. (Physical Research Lab., Ahmedabad, India). pp 178-94 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

The diurnal variation in cosmic-ray intensity is caused by an anisotropy which, on the average, has a magnitude of ~0.4% in 1800 hours direction in space. Its dependence on the energy E of primary particles can be expressed by E^0, and its strength falls off as cos λ with asymptotic latitude of viewing of the detector. Taking into account electromagnetic conditions of interplanetary space, Ahluwalia and Dessler, Stern, Parker, Axford, and Krymskii have put forward mechanisms to explain the anisotropy. All mechanisms require that the pressure gradient produced by the electric field $E = -V \times B/C$ should vanish. Parker has proposed that this is accomplished by the scattering due to magnetic field irregularities in interplanetary space beyond the orbit of the earth, while Axford and Krymskii have brought this out from symmetry considerations. Effects of density gradients perpendicular

to the ecliptic plane have been investigated by Sarabhai and Subramanian. They are able to explain the observed semidiurnal component having its direction of maximum perpendicular to the interplanetary magnetic field. The daily variation on a day-to-day basis is more complex than the average picture. On the experimental side the need to get more precise data is to be stressed, and from the theoretical side, models more complicated than the simple spherically symmetric modulation, are required. (auth)

3717 SOME CHARACTERISTICS OF THE DAILY VARIATION OF COSMIC RAY INTENSITY. Kane, R. P. (Physical Research Lab., Ahmedabad, India). pp 195-204 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

Characteristics of the daily variation of nucleonic component of cosmic-ray intensity are studied by different methods for the Quiet-Sun period 1964, and for I.G.Y. It is found that the daily variation consists mostly of linear gradients (constant rate of increase or decrease per hour) which end up in sharp or broad maxima or minima (sources or sinks) whose origins are most probably outside the geomagnetic field and of an energy-independent spectrum. The average directions of the source and sink are 18 and 6 hrs (L.T.) but variations of ±2 hrs or more are observed from day to day. The amplitude also varies widely. A partial independence of the source and sink is indicated. There is no major dependence on solar activity except that phases are sharper in Quiet-Sun period. (auth)

3718 DIURNAL VARIATION OF COSMIC RAYS DURING THE DECLINE PERIOD OF SOLAR ACTIVITY. Murthy, D. S. R.; Nagabhushanam, Y.; Rao, K. Ramanuja (Osmania Univ., Hyderabad, India). pp 205-9 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

The yearly mean diurnal amplitude and phase for the neutron monitor data obtained from ten different stations for the year 1962 are calculated. The results reveal that the amplitude of the diurnal variation increases with geomagnetic latitude up to about 65° and falls off at higher latitudes, in general agreement with the IGY results and those predicted theoretically. However, these results also show that further analysis of the observations at higher latitudes is needed to observe any changes in the distribution of the power of the source perpendicular to the plane of the ecliptic. The results also show the shift in the phase of the diurnal variation to later hours with increasing geomagnetic latitude from the equator. (auth)

3719 CHANGES IN THE CHARACTERISTICS OF THE ANISOTROPY OF GALACTIC COSMIC RAYS WITH SOLAR ACTIVITY. Subramanian, G.; Sarabhai, V.; Patel, D. (Physical Research Lab., Ahmedabad, India). pp 210-16 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

Results are obtained from a more rigorous study of the cosmic-ray anisotropy than that presented by Sarabhai and Subramanian at the 9th International Conference on Cosmic Rays, London, 1965. This is accomplished by considering only those days on which good resolution is possible in the determination of the spectrum of variation. Two groups are obtained: for the first, the exponent x ranges from 0 to −1.0, while E_{min} has a value 2 GeV; and for the other, x ranges from +1.0 to −1.0 while E_{min} = 15 GeV. With declining solar activity the number of days in Group I (E_{min} = 2 GeV) increases by 10% and in Group II (E_{min} = 15 GeV) decreases by the same amount, in conformity with earlier results. Other characteristics of the anisotropy remain unchanged with solar activity. The semidiurnal component is more predominant in group II than in group I. Using the days in group I and group II as epochs, a Chree analysis is done on solar (λ 5303°), geomagnetic (ΣK_p), and cosmic-ray data (Deep River neutron intensity). The results indicate that, on days corresponding to group I, electromagnetic conditions of interplanetary plasma are similar to what one would expect in a "cavity" when slow plasma trails behind fast plasma. Days in group II correspond to conditions in the shock front where fast plasma collides with slow plasma. (auth)

3720 EXPLANATION OF THE SEMI-DIURNAL ANISOTROPY OF GALACTIC COSMIC RAYS. Subramanian, G.; Sarabhai, V. (Physical Research Lab., Ahmedabad, India). pp 217-27 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

The authors have suggested previously that, at most periods of the solar cycle, density at a given radial distance from the sun would be less along the solar equatorial plane than on either side of it. It is pointed out here that a cosmic-ray telescope scanning the solar equatorial plane would observe along the direction of the spiraling magnetic field intensity corresponding to the density in the equatorial plane. However, when viewing along a direction perpendicular to the spiraling field the same telescope would observe intensity corresponding to higher cosmic-ray density at a distance of the order of a gyroradius above or below the equatorial plane. This would give rise to a semidiurnal anisotropy at a detector on the spinning earth, the direction of maximum of the anisotropy being perpendicular to the magnetic field. Because of the dependence of the effect on the gyroradius stronger anisotropy should be observed for higher-energy particles. The dependence of the anisotropy on the asymptotic latitude of viewing is also such that the semidiurnal anisotropy should be more pronounced at equatorial stations. (auth)

3721 INTERPLANETARY MEDIUM. Tarafdar, S. P. (Tata Inst. of Fundamental Research, Bombay). pp 228-39 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

The physical properties of the interplanetary medium are discussed from two different considerations assuming polytropic law for the temperature. One of them is that the gas kinetic pressure in the interplanetary medium is much higher than the magnetic pressure. Though this consideration gives the observed magnitude of the magnetic field, velocity, and particle density at earth's orbit, it is shown that there are some drawbacks of this weak field model. The alternative approach is based on the assumption that the magnetic pressure is much higher than the gas kinetic pressure. Starting with this idea, the physical properties of the interplanetary medium have been worked out. It is shown that this strong field model keeps all the merits of the weak field model and removes its drawbacks too. (auth)

3722 TEMPORAL INDEPENDENCE OF THE OCCURRENCE OF SMALL SCALE IRREGULARITIES IN THE INTERPLANETARY MAGNETIC FIELD. Rao, U. R. (Physical Research Lab., Ahmedabad, India); McCracken, K. G. pp 240-7 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

From a critical examination of the cosmic-ray daily variation observed by various neutron monitors all over the world it is concluded that the frequency of occurrence and the characteristics of small-scale magnetic field irregularities in the interplanetary plasma are independent of the phase of the sunspot cycle. (auth)

3723 SECTOR STRUCTURE OF SOLAR ACTIVITY AND THE ELECTROMAGNETIC CONDITIONS OF INTERPLANETARY SPACE. Pathak, P. N.; Sarabhai, V. A.; Subramanian, G. (Physical Research Lab., Ahmedabad, India). pp 248-53 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

The sector structure of the interplanetary magnetic field as revealed by the IMP-1 satellite is compared with a derived index of the coronal 5303 Å emission intensity at c.m.p. at the solar equator. It is observed that sectors where the magnetic field lines point outwards from the sun are associated with highly excited regions where the solar wind velocity is enhanced. The correlated changes in K_p and cosmic-ray intensity show that high K_p is caused by at least two different types of interplanetary conditions. In one case where high K_p is associated with decreases of cosmic-ray intensity, coronal conditions indicate the development of a shock transition due to fast wind blowing behind slow. In the other condition when high K_p occurs with recovery of cosmic-ray intensity, the earth emerges out of a "cavity" which develops due to slow plasma following fast plasma. (auth)

3724 EXTENSIVE AIR SHOWERS. Naranan, S. (Tata Inst. of Fundamental Research, Bombay). pp 254-71 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

Extensive air showers (EAS) play important roles in two major areas of physics: High-energy astrophysics and high-energy nuclear physics. Information from EAS studies is indirect but no direct measurements are feasible at these energies because of the low flux of primaries of energy $>10^{15}$ eV (~1/d m² st.). To study the properties of radiation of such low flux, very large detecting areas are needed; in EAS, because of the lateral spread of the shower particles of the electromagnetic and nuclear cascade, large effective detection areas can be achieved—from thousands of m² to several km² depending on the primary energy. The astrophysical problems relate to the primary cosmic radia-

tion itself; its properties will elucidate the questions of its origin, acceleration, and propagation in the universe. The problems pertaining to high energy nuclear physics deal with the secondary products of the collisions of the primary particle, and the subsequent collisions of nucleons and pions of the nuclear cascade. (auth)

3725 NEUTRINO PHYSICS AND NEUTRINO ASTROPHYSICS. Ramanamurthy, P. V. (Tata Inst. of Fundamental Research, Bombay). pp 272-91 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

During the past 15 years some very important experiments have been performed on neutrinos produced in the laboratory, thus elevating the subject of neutrino physics to experimental status. The natural neutrinos, their mode of production, the possible experiments, and the information one is likely to extract from such experiments are considered in this paper. (auth)

3726 CHARACTERISTICS OF A DOUBLE MAGNET COSMIC RAY SPECTROGRAPH TO BE BUILT AT DURGAPUR. Nandy, B. C.; Sinha, M. S. (Regional Engineering Coll., Durgapur, India). pp 359-67 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

The characteristics and design features of a double magnet cosmic-ray spectrograph to be built at Durgapur for studying the momentum-specific ionization relation of muons in the range of momentum 12 GeV/c to 1286 GeV/c and to measure their charge ratio are discussed. The arrangement would be such that muons would trigger a three-fold coincidence of scintillation counters and their momentum would be determined from combined angular deflection in two large solid iron magnets with a scattering error of 17%. For studying variations of magnetic induction, B, an experiment on a model magnet, made from a Rourkela-make steel plate was performed and the variation was found to be below ±1% with the saturation field of 14 kG. (auth)

3727 THE DIRECT PRODUCTION OF ELECTRON PAIRS BY MUONS IN MEDIUM AND LOW Z ELEMENTS. Das, A. K.; Sinha, M. S. (Regional Engineering Coll., Durgapur, India). pp 368-78 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

Direct production of electron pairs in carbon, aluminium, and copper targets of thicknesses 0.06, 0.14, and 0.44 radiation units respectively, was studied with two multiplate cloud chambers with muons of mean energy 6 GeV and minimum energy 0.8 GeV. The two cloud chambers, one containing aluminium plates and the other with copper and carbon plates in two successive experiments, were operated simultaneously and triggered by means of four-fold coincidence system of G-M counters. Showers of two or more electrons associated with each outgoing muon from the targets were selected and the energy transfer in each event was estimated. The cross sections as determined experimentally were corrected for double knockon and other possible processes and compared with the theoretical cross section for direct pair production (d.p.p.) as given by the Murota-Ueda-Tanaka (MUT) theory. The experimental values of d.p.p. cross sections for the elements carbon, aluminium, and copper show good agreement with theory in the region of energy transfers (10 to 60), (60 to 200), and (200 to 500) MeV. The data also exhibit clearly the expected Z dependence of the cross section. Furthermore, a comparison of the present data with those of other laboratories indicates an increase of the cross section with muon energies as predicted by the MUT theory. (auth)

3728 SPACE SCIENCE STUDIES WITH CHARGED PARTICLE TRACKS IN SOLIDS. Price, P. B. (Tata Inst. of Fundamental Research, Bombay). pp 387-410 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

Massive, energetic charged particles on traversing certain dielectric solids leave radiation-damage tracks that are preserved for geological times and can at any time be magnified to visible size by preferential chemical attack. Their microscopic study has several interesting geophysical and astrophysical applications. Fossil tracks of spontaneously fissioned uranium nuclei provide a versatile method for dating various terrestrial materials. Fossil plutonium fission tracks in meteorites can be related to the cooling history of the meteorite parent body. Fossil cosmic-ray tracks in meteorites allow one to deduce the ancient abundance of very heavy primary cosmic rays. Large area plastic sheets can be flown in balloons to search for rare very heavy nuclei in the present-day cosmic rays. Various applications of dielectric track detectors reviewed. (auth)

3729 ISOTOPIC CHANGES INDUCED BY COSMIC RAYS IN TERRESTRIAL MATERIALS. Rama (Tata Inst. of Fundamental Research, Bombay). pp 411-21 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

Cosmic-ray interactions in the atmosphere account for the major part of the isotopic changes induced in the terrestrial environment. Several applications of these in problems of geophysical interest are enumerated. The magnitudes of the estimated isotopic effects in the crust are very small but not entirely negligible. Recent developments in mass spectrometery and low-level radiometery make their detection possible in some favorable cases for which suitable crustal samples can be procured. The usefulness of a few such experiments in geophysical investigations is discussed. (auth)

3730 COSMIC RAY RECORDS IN METEORITES. Goel, P. S. (Indian Inst. of Tech., Kanpur, India). pp 422-39 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

Some of the more important developments in the field of the cosmic-ray history of meteorites are discussed. The three types of meteorites — stones, irons, and stony irons — are considered. Most of the significant developments so far have been towards a better understanding of meteorites themselves, but it is shown that enough is known about meteorites that one can discuss cosmic-ray variations as well. The history of meteorites is discussed in terms of terrestrial and exposure ages and cosmic-ray variations in terms of the present, million-year range, and billion-year range. (W.D.M.)

Direct Energy Conversion

Refer also to abstracts 3486 and 3738.

3731 (N-66-29332) DC STATES OF PLASMA DIODES. Quarterly Status Report No. 12, January 1-April 1, 1965. (Stanford Univ., Calif. Stanford Electronics Labs.). 18p. (NASA-CR-62729). CFSTI $3.00 cy, $0.65 mn.

Stationary potential distributions between parallel plane electrons and ion emitting surfaces are studied. A theory is outlined for calculating the dc characteristic of a cesium plasma diode to find out if a negative slope is obtained under certain critical conditions. The space charge equation is programmed for more convenient computation, using a second order difference operator. Equations are presented for the coexistence of surface phases and diffusion. The feedback of ions from the potential maximum in front of the emitter is investigated to determine whether it is a more effective means to redistribute the adsorbate between the surface phases. Expansion of a computer program for studying the randomization of electron energies in thermionic diodes is also discussed. This involved simulation of emission properties of a hot tungsten plate partially covered with cesium, and of electron-neutral and ion-neutral collision simulations by random processes. (STAR)

3732 DIRECT CONVERSION OF NUCLEAR ENERGY INTO ELECTRICAL ENERGY WITH THERMIONIC ELEMENTS. Langpape, R. (Brown, Boveri u Cie. AG, Mannheim, Ger.). Waerme, 72: No. 1, 1-9(1965). (In German).

In a thermionic element electric current is obtained directly from heat by means of the so-called thermionic effect. This thermionic effect, i.e., the fact that a hot metal emits electrons, has been known for a long time. However, only since 1959 has there been extensive development of thermionic elements. The construction and operation of these elements are briefly outlined. The efficiency of present thermionic elements is discussed. The lifetime and operational data on thermionic elements are reported. Possible uses are indicated, and their present use in connection with nuclear reactors is discussed in some detail. (J.S.R.)

3733 INTERACTION OF LITHIUM WITH IMPURITIES AND DEFECTS IN SILICON. Fang, P. H. (Goddard Space Flight Center, Greenbelt, Md.); Liu, Y. M. Appl. Phys. Lett., 9: 364-6(Nov. 15, 1966).

Defects in silicon p-on-n solar cells with a lithium-diffused n region, produced by electron irradiation and spontaneously annealed at room temperature, are interpreted as lithium atoms. (auth)

3734 MAGNETOHYDRODYNAMIC GENERATING SYSTEM. Brenner, William C.; Chapel, Fox; Tuba Istvan (to Westinghouse Electric Corp.). U. S. Patent 3,280,349. Oct. 18, 1966. Filed Oct. 21, 1963.

An MHD generating system is described in which voltage and

current are efficiently generated. Also, a uniformly distributed magnetic flux is efficiently produced. The MHD system has a generating duct arrangement in which ionized gas flows bi-directionally so that magnetic flux generating means can be provided with optimal capacity. (M.O.W.)

3735 STATIC CONVERTERS OF THERMAL ENERGY, IN PARTICULAR OF NUCLEAR ORIGIN, INTO ELECTRIC ENERGY. Klein, Siegfried; Surdin, Maurice; Weill, Jacky (to Commissariat a l'Energie Atomique). U. S. Patent 3,277,321. Oct. 4, 1966. Priority date Mar. 16, 1962, France.

A series of pairs of electrodes is disposed at the periphery of at least one hot thin ionized jet of vapor. Each pair comprises a noncooled and a cooled electrode. The noncooled electrode of every pair is electrically connected with the cooled electrode of the next pair, from which it is thermally insulated. Between the cooled electrode of the first pair and the noncooled electrode of the last pair a voltage equal to the sum of the elementary voltages produced in every pair of electrodes. (M.H.R.)

3736 IMPROVEMENTS IN AND RELATING TO APPARATUS FOR THE DIRECT GENERATION OF ELECTRICITY. Lindley, Bryan Charles (to C. A. Parsons and Co. Ltd.). British Patent 1,045,878. Oct. 19, 1966. Filed Sept. 3, 1962.

A magnetohydrodynamic generator is described wherein the duct is defined by a number of adjacent walls at least one of which is mounted so that its position relative to the other walls can be altered to vary the flow area of the duct along its length. This allows for variations in power output without substantial loss of efficiency. (W.D.M.)

Fluid Physics

Refer also to abstract 3856.

3737 SOUND WAVES IN RELATIVISTIC MAGNETOHYDRODYNAMICS. Kanwal, R. P. (Pennsylvania State Univ., University Park). J. Math. Mech., 15: 379-92(Mar. 1966).

Some previous mathematical treatments of the coupled motion of hydrodynamic flow and electromagnetic fields are considered, indicating that in the study of nonrelativistic magnetohydrodynamics only the quasi-equilibrium approximation to the electrodynamic equations are adopted in which the displacement currents and charge accumulations are ignored. Such an analysis merely allows the possibility that the velocities, both random and ordered, of fluid elements are comparable with the classical velocity of sound. In recent attempts to give a covariant formulation to magnetohydrodynamics these approximations were not introduced. The motion of sonic discontinuities is considered with such a covariant formulation, by comparing and extending the salient features of earlier analyses. Equations governing the flow of a perfect relativistic gas were coupled with those of electrodynamics. The total energy tensor, thus obtained, enabled a comparison of various known results on wave motion. Only those fluids which have infinite conductivity are dealt with. A weak disturbance whose propagation can be represented by a time-like hypersurface in an Einstein–Riemann space is examined. By using the concept of singular surfaces across which all the magnetohydrodynamic quantities are continuous but the first derivatives of at least one of these quantities is discontinuous, various speeds of propagation of these surfaces are obtained. The results are compared with the known results in this field, and by taking a suitable metric a space–time representation of the analysis is given, which enables comparison of the present discussion with that known for nonrelativistic magnetohydrodynamics. It is shown that qualitatively the present results are similar to the ones known for the nonrelativistic case. (BBB)

3738 INFLUENCE OF ELECTRODE EDGES ON THE MAGNETOHYDRODYNAMIC FLOW IN CHANNELS. Dragos, Lazare (Univ., Bucharest). Compt. Rend., Ser. A, 263: 328-31(Aug. 29, 1966). (In French).

The influence of the electrode edges of an MHD generator on the flow in the channels is studied without restricting the Reynolds magnetic number to a small quantity. Both the induced magnetic field and the interaction of this field with the flow are considered. The exact solution to the problem is derived. (G.O.Y.)

3739 ALFVEN OSCILLATIONS IN AN ELECTRICALLY SUSTAINED CONDUCTING LIQUID. Alais, P. (Univ., Paris). J. Phys. (Paris), 27: 469-79(July-Aug. 1966). (In French).

Alfvèn standing waves may be excited by electrical currents injected with electrodes or generated by induction in a toroidal or cylindrical cavity of rectangular cross section containing a conducting liquid in the presence of a uniform magnetic induction. Different ways of generating such an electromagnetic excitation are presented theoretically for this type of cavity. By using liquid sodium, one may expect to obtain, without too great technical difficulties, relatively high Q resonances. This type of excitation also permits the detection of the oscillations created in the liquid by a simple measurement of impedance. A toroidal cavity of square cross section and of large radius (quasi-cylindrical) was investigated with an inductive excitation. Impedance measurements were compared with results obtained from a network of capacitances, inductances, and resistances simulating the problem as it is exposed in the theory. This kind of computation may be used for other more complex problems and it has been interesting to test its accuracy with the numerical determination, in some special cases, of the analytical solution which is also given. (auth)

3740 MOTION OF A CONDUCTING DISSOCIATING GAS IN A CONSTANT-CROSS-SECTION CHANNEL PLACED IN A MAGNETIC FIELD. Veretennikov, B. N. (All-Union Scientific-Research Inst. of Electromechanics, USSR). Teplofiz. Vysok. Temp., 4: 285-6(Mar.-Apr. 1966). (In Russian).

A stationary flow of the gas in a rectangular channel is theoretically considered. A constant magnetic field is applied at right angles to the insulating channel walls. The conducting walls are connected to a load. No external voltage is applied. Equations of energy conservation, momentum conservation, state, continuity, and dissociation (vs. pressure and temperature) were set up; these five equations were integrated on a digital computer and the results were compared with those for a nondissociating gas. It was found that: (1) the dissociation causes an additional acceleration and heating of gas, and (2) it lowers the enthalpy conversion factor. (ATD)

3741 EFFECT OF LONGITUDINAL MAGNETIC FIELD ON THE HYDRAULIC RESISTANCE TO MERCURY FLOW IN A CIRCULAR PIPE. Genin, L. G.; Zhilin, V. G. (Moscow Power-Engineering Inst.). Teplofiz. Vysok. Temp., 4: 233-7(Mar.-Apr. 1966). (In Russian).

The results are reported of an experimental investigation of the effect of longitudinal magnetic field on the hydraulic resistance to mercury flow in a circular pipe, with Hartmann numbers up to 140 and Reynolds numbers from 1000 to 50000. The mercury was circulated by a stainless-steel-sealed 7500-kg/hr pump at a pressure up to 6 atm. With no magnetic field applied, the experimental data in the turbulent region were in fairly good agreement with the well-known Blasius formula. With a magnetic field applied, three characteristic regions were observed: (1) At $Re < 2300$, the magnetic field effect was negligible, and the experimental points coincided with the Poiseuille line; (2) At $2300 < Re < Re_{crit}$, the experimental points were above the Poiseuille line for all values of the magnetic induction; (3) At $Re > Re_{crit}$, the hydraulic resistance rapidly increased with Re, reached its maximum, and then fell off asymptotically approaching its value that corresponded to no magnetic field. The magnetic field, apparently, suppresses the turbulent pulsations of velocity, the suppression being weaker for smaller turbulence. (ATD)

3742 ELECTROHYDROSTATIC PROBLEMS FOR A FREE LIQUID SURFACE. Cade, R. (Univ. of Puerto Rico, Mayaguez). J. Appl. Phys., 37: 4396-4404(Nov. 1966).

Solutions are obtained of the equation that, with the assumption of axial symmetry, governs the form of a liquid surface in an electrostatic field, the liquid being electrically conducting in bulk and having a double layer at the surface. The problems concerned are ones in which, in the absence of an applied field, the surface would be a horizontal plane (a free surface). Those of the line charge and point charge are basic and are solved in the first approximation. Extensions are made in three interwoven directions, solutions to the second approximation, more complicated given charge systems, and conductors (the cylinder and sphere). A complete second-approximation solution is obtained for the line-charge problem; partial solutions of this order are obtained for the cylinder and sphere problems and have the features one would want in practical applications of the results. (auth)

3743 ELECTRODE STRUCTURES FOR AN MHD GENERATOR. Way, Stewart (to Westinghouse Electric Corp.). U. S. Patent 3,275,860. Sept. 27, 1966. Filed July 13, 1962.

An electrode structure is described for use in a magnetohydrodynamic energy conversion apparatus, wherein, a flow of thermally ionized working fluid is passed adjacent to a surface of the electrodes. The electrode structure is such that an electrically conducting protective gas is passed through the electrode into the flow of thermally ionized working fluid. The protective gas acts to provide a layer of oxygen-free gas near the surface of the electrode and to maintain an electrically conducting gas layer between the electrode and the working fluid. (M.H.R.)

3744 INSULATING VANES FOR LINEAR MHD DEVICES. Meyerand, Russell G. Jr.; Lary, Edmund C. (to United Aircraft Corp.). U. S. Patent 3,275,859. Sept. 27, 1966. Filed Oct. 2, 1961.

The use of axially extending insulating vanes at or adjacent to the inlet and exit of the energy exchange portion of an ac linear MHD device is proposed. These allow easy and deep penetration of the magnetic field into the conducting fluid and provides for ease of removal of the field. The insulating vanes are used to support a ferromagnetic centerbody extending the length of the energy exchange portion of the MHD device. (M.H.R.)

3745 MAGNETOHYDRODYNAMIC GENERATORS. Fabre, Jean; Croitoru, Zicu (to Electricite de France). U. S. Patent 3,278,798. Oct. 11, 1966. Priority date Apr. 1, 1963, France.

Arcs in a conduit of an MHD generator are produced by means of voltage pulses having a sufficient amplitude to produce discharges or arcs between the discharge ends of a series of pairs of ionization electrodes, which are distinct from the collecting electrodes carried by the side walls. The discharge ends of every pair of ionization electrodes are located opposite each other in the gaseous stream inside the conduit. The voltage pulses are applied between every pair of input ends located outside the conduit. (M.H.R.)

3746 IMPROVEMENTS IN OR RELATING TO THE MEASUREMENT OF PLASMA VELOCITY. Swift-Hook, Donald Thomas; Nation, John Arthur (to Central Electricity Generating Board). British Patent 1,047,154. Nov. 2, 1966. Filed Mar. 18, 1964.

A measurement technique for plasma or gas velocity in magnetohydrodynamic electric generators is described. (M.O.W.)

3747 APPARATUS FOR MAGNETOHYDRODYNAMICALLY GENERATING ELECTRIC ENERGY. Brogan, Thomas R. (to Avco Corp.). U. S. Patent 3,274,407. Sept. 20, 1966. Filed Feb. 2, 1961.

An MHD generator employing a stationary magnetic field and unidirectional gas flow is described. The plasma or conductive gas is cooled by reducing the conductivity, thereby reducing the short circuiting and losses due to eddy currents. This is accomplished by injection of a nonconductive gas into the conductive gas at a point downstream of the electrodes. Improved apparatus is also provided for more efficiently transforming the kinetic energy of the conductive gas into electric energy. (M.H.R.)

Geophysics

Refer also to abstracts 3592, 3702, 3729, and 3730.

3748 (N–66-29366) FLUID MODEL FOR THE INTERACTION OF THE SOLAR WIND AND THE GEOMAGNETIC FIELD. Spreiter, John R.; Summers, Audrey L.; Alksne, Alberta Y. (National Aeronautics and Space Administration, Moffett Field, Calif. Ames Research Center). [1965]. 19p. (NASA-TM–X-56892). CFSTI $3.00 cy, $0.65 mn.

Systems of equations are presented for describing the interaction of the solar wind and the geomagnetic field in terms of a continuum theory of fluid flow. A procedure is indicated by which the results for the magnetosphere boundary, the bow wave, and the associated flow field can be arrived at from a purely fluid point of view without resort to a mixture of particle and fluid models as usually employed; and numerical results for the flow parameters in the shock layer between the bow wave and the magnetosphere boundary are presented. The fundamental assumption is that the flow can be described adequately by the standard magnetohydrodynamic equations for steady flow of a dissipationless perfect gas. Data curves from the literature relating to streamlines, waves patterns, constant velocity, mass flux, density, and temperature for supersonic flow past the magnetosphere are included. (STAR)

3749 (N-66-29739) STRUCTURE OF THE SOLAR PLASMA FLOW GENERATED BY SOLAR FLARES. Akasofu, S.-I.; Yoshida, S. (State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy. Alaska Univ., [College]). Apr. 1966. 52p. (NASA-CR-76013). CFSTI $3.00 cy, $0.65 mn.

Characteristics of geomagnetic storms caused by solar flares at different central meridian distances are statistically examined to obtain a two-dimensional configuration of the solar plasma flow generated by solar flares. It is shown that the front of the plasma flow is nearly semi-spherical, but its energy flux is greatly concentrated in a narrow cone from intense solar flares; therefore, the energy flux has a jet structure. It is shown that these results can be reasonably combined to give a consistent picture by assuming the generation of an interplanetary shock wave by the jet of the solar plasma ejected by a solar flare. (auth)

3750 IONOSPHERIC TOPSIDE SOUNDING. Calvert, W. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). Science, 154: 228-34(Oct. 14, 1966).

Satellite observations of radio echoes are used to study the structure of the upper ionosphere. The satellite topside measurements of ionospheric electron density essentially agree with similar measurements from the ground, except for an occasional 10% discrepancy near the peak of the ionosphere. While horizontal nonuniformity is a likely cause, this discrepancy has not yet been adequately explained. The electron-density scale heights measured at a constant altitude indicate both a higher temperature and a heavier mean ion mass at high latitudes. At low latitudes the topside measurements show the detailed latitudinal structure of the equatorial anomaly, demonstrating control by the geomagnetic field. The complex structure of the ionosphere near the auroral zone and at higher latitudes is studied. The topside sounders are used in various plasma studies and the results indicate that the ionosphere is an appropriate region for future plasma physics investigations. (J.H.M.)

3751 MEASUREMENTS OF TOTAL ELECTRON CONTENT NEAR THE MAGNETIC EQUATOR. Skinner, N. J. (Ahmadu Bello Univ., Zaria, Nigeria). Planet. Space Sci., 14: 1123-9(Nov. 1966).

The columnar electron content, n_T, was measured at Zaria for a 9-month period by the "close-spaced frequency" method using the 40 and 41 Mc transmissions from the beacon satellite S-66 (BE-B). The diurnal variation of n_T for periods of local summer, spring equinox, and local winter show double-peaked daytime maxima, somewhat similar to those for NmF, the peak electron densities. An explanation is proposed in terms of the diurnal development of the equatorial geomagnetic anomaly in the F region and this is also thought to explain the large values of scale height observed in the period 0900 to 1500 hours. The early morning peak in scale height is thought to be caused by ionization of the topside ionosphere prior to ground sunrise. (auth)

3752 AMPLIFICATION OF ELECTROMAGNETIC DISTURBANCES IN THE NON-UNIFORM IONOSPHERE. Hruska, A. (Geophysical Inst., Prague). Planet. Space Sci., 14: 1077-83(Nov. 1966).

The wave-power amplification by high-velocity particles in the ionosphere with an exponential density profile is calculated, provided the wave length of the perturbation is much smaller than the scale-height of the electron density. The enhancement of waves is a maximum for protons fulfilling somewhere in the ionosphere the condition for cyclotron resonance. The maximum ratio of the flux of the proton energy (calculated at the "upper boundary" of the ionosphere) available for the amplification of waves to the time-averaged flux of the wave energy is of the order of 10^{-2} for unit density of protons. It is shown that the heights far above the F2 peak seem to be more likely localities for wave enhancement than the ionosphere. (auth)

3753 EXTENT OF THE EMISSION REGION ON JUPITER AT 408 Mc/s. McAdam, W. B. (Univ. of Sydney). Planet. Space Sci., 14: 1041-6(Nov. 1966).

Observations of the emission region on Jupiter were made with the E–W arm of the 1-mile Mills Cross. The extended Van Allen belt resolved in right ascension by the 88′ arc fan beam, and a model of the brightness distribution compared with the more detailed models obtained at higher frequencies. Most emission comes from within 1.6 Jovian radii of the center, but there is a region at 6 radii that contributes 16 to 20 per cent of the flux. (auth)

3754 POLAR LIGHTS IN MIDDLE LATITUDES AND INSTABILITIES IN THE OUTER RADIATION BELT. Schroeder, Wilfried (Geophysikalische Station, Bremen). Beitr. Geophysik, 74: 474-8 (1965). (In German).

The relations between the leakage of the outer van Allen belt, solar and geomagnetic activity, and visually observed aurorae in middle latitudes are discussed. Large leakage as a result of magnetic storms and polar lights (particularly at $\Phi - 57$ to 58°) are correlated for 16 August 1959; other correlations are observed for 28 Nov. 1959, 1 Apr. 1960, and particularly for 4 Sept. 1958, for which no correlation of aurora with solar activity could be made. Other data recorded over central Europe by Explorer VII are also correlated with polar lights. After a magnetic storm a strong refilling of the radiation belt lasting up to 15 days occurs; during this period the belt is quite sensitive to distortions, so that relatively weak solar streams can renew the instability of the belt. Such a relation is applicable only to a few observations; more data should be gathered during the IQSY. (BBB)

3755 VARIATIONS OF ABNORMAL LONG DISTANCE PROPAGATIONS OBSERVED BY BACKSCATTERING. Crochet, Michel; Delloue, Jean (Laboratoire de Physique de l'Exosphere, Orsay, France). Compt. Rend., Ser. B, 263: 517-20(Aug. 17, 1966). (In French).

The long-distance propagations are observed regularly in con-

nection with the horizontal ionospheric gradients at sunrise and sunset. Their daily and seasonal occurrences are rightly connected with the variations of confinement height along the trajectory. (tr-auth)

3756 BEARING ANGLE ESTIMATION OF ATMOSPHERIC SONIC PLANE WAVES USING GROUND ARRAYS. Blum, M. (RAND Corp., Santa Monica, Calif.). pp 13-18 of Proceedings of the National Electronics Conference. Vol. XXII. Chicago, National Electronics Conference, Inc., 1966.

A method of estimating the bearing angle of an incoming plane wave using an arbitrary ground array of sensors is presented. The method is of interest in the detection of nuclear bursts above the ground, and should be useful to those concerned with acoustics and seismology. (J.H.M.)

3757 PROTON FLARES BEFORE 1956. Svestka, Z. (Astronomical Inst., Czechoslovak Academy of Sciences, Ondrejov). Bull. Astron. Inst. Czech., 17: 262-70(1966).

Observational results of vertical incidence ionospheric soundings made at high-latitude stations before 1956, made it possible to find 47 highly probable PCA events during 1938 to 1955 and to identify 32 of them with observed or hypothetical proton flares (these being unobserved flares in the only important active region on the solar disk present on the day of the PCA occurrence). These quite new PCA data fully confirm the deficiency of the PCA occurrence in the northern winter months, the very strong western preference for flares producing strong PCA events with a steep limit of occurrence at about 10°E on the solar disk, the north–south asymmetry of flares producing PCA's, and the dependence of the PCA delay time on the season, PCA importance, and heliographic longitude of the proton flare. A comparison of the records by vertical incidence soundings during 1956 to 1959 with known PCA data allowed a fairly homogeneous set of data on strong PCA's to be obtained for the whole period 1938 to 1963 and some conclusions to be drawn on the PCA occurrence in various phases of the solar activity. A relative decrease of the number of observed PCA events during the maximum phase of the solar cycle is in a good agreement with the well-known absence of GLE's in the maximum years. It can be predicted that about 10 PCA's can be expected in 1966 and yearly about 25 events in 1967 and 1968, approximately 30% of them being strong PCA events. (auth)

3758 THEORETICAL PROTON VELOCITY DISTRIBUTIONS IN THE FLOW AROUND THE MAGNETOSPHERE. Spreiter, John R.; Alksne, Alberta Y.; Abraham-Shrauner, Barbara (Ames Research Center, Moffett Field, Calif.). Planet. Space Sci., 14: 1207-20(Nov. 1966).

Relations from kinetic theory are combined with results from fluid calculations to determine a microscopic interpretation of the properties of the solar wind as it flows around the magnetosphere. Proton velocity distributions are presented as a function of the particle speed and direction for several points in space for representative values of the solar wind parameters. The results illustrate how the velocity distribution is highly collimated in the incident stream, is completely isotropic at the magnetosphere nose, and the degree to which it changes back to that of a highly collimated stream along the flanks of the magnetosphere. Except for a very small region in the vicinity of the magnetosphere nose, the number of particles that move in the upstream direction is insignificantly small compared with the number that move in the direction of the bulk velocity. The most probable speed of the protons, as viewed in a frame fixed in the Earth, is always in the direction of the local bulk velocity, and tends to be relatively constant throughout the flow in spite of substantial changes in temperature and bulk velocity. A discussion is given of the relation of these results to the measurements that would be made by various types of instruments commonly used to observe plasma flows in space. (auth)

3759 INVERSIONS AND ORIGIN OF THE GEOMAGNETIC FIELD. Dauvillier, Alexandre (Observatoire du Pic du Midi, Bagneres, France). Compt. Rend., Ser. B, 779-83(Sept. 26, 1966). (In French).

It is suggested that the paleomagnetic inversions of the earth should be attributed to electromagnetic induction effects produced by corpuscular solar eruptions with a cadence of 10^5 years. (tr-auth)

Low-Temperature Physics

Refer also to abstracts 3214, 3356, and 4182.

3760 (COO–1198-383) HEAT CAPACITY OF DILUTE SOLUTIONS OF LIQUID ^{3}He IN ^{4}He AT LOW TEMPERATURES. Roach, William Ronald (Illinois Univ., Urbana). Aug. 1966. Contract AT(11-1)-1198. 103p. Dep. mn. CFSTI $4.00 cy, $0.75 mn.

Thesis.

Heat capacity measurements were made on two dilute solutions of liquid ^{3}He in ^{4}He. These data, taken under saturated vapor pressure at temperatures between 0.005 and 0.20°K, are characteristic of an ideal Fermi gas with m* (effective mass of ^{3}He quasiparticle) dependent only slightly on concentration. The solution with a molar concentration of ^{3}He of 1.32 ± 0.01% had a degeneracy temperature of 0.141 ± 0.002°K and m*/m = 2.38 ± 0.04. For the solution with a 5.02 ± 0.03% concentration of ^{3}He, the degeneracy temperature was 0.331 ± 0.004°K while m*/m = 2.46 ± 0.04. The slight dependence of m* on concentration can be explained in terms of the Landau theory of a Fermi liquid. The perturbation method, which Bardeen, Baym, and Pines used to determine an effective potential v(q) between ^{3}He quasiparticles from later data on the magnetic properties of these solutions, was used to estimate the low-temperature contribution of the ^{3}He quasiparticles to the thermal conductivity and viscosity of dilute solutions. (auth)

3761 (COO–1198-384) PROPAGATION OF ZERO SOUND IN LIQUID ^{3}He. Abel, William R. (Illinois Univ., Urbana). Aug. 1966. Contract AT(11-1)-1198. 67p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

The propagation of sound in liquid ^{3}He was observed at a pressure of 0.32 atm and at frequencies of 15.4 and 45.5 MHz down to a temperature T* of 2m°K (1m°K = 10^{-3} °K) on the temperature scale valid for the Curie-law magnetic susceptibility of powdered cerium magnesium nitrate in the form of a right circular cylinder with diameter equal to height (T* is magnetic temperature of powdered CMN). The results of the measurements have been published. As the temperature was increased, the sound attenuation increased, went through a maximum, and then decreased. At low temperatures, the attenuation was proportional to T^{*2} but independent of frequency, and at higher temperatures it was proportional to ω^2/T^{*2}, where ω is the angular frequency of the sound. The temperature at which maximum attenuation occurred was 11.3m°K for the frequency of 15.4 MHz and was 19.3m°K for 45.5 MHz. The velocity of the sound was found to be relatively temperature independent at high and low temperatures but near the attenuation maximum the velocity changed by 3.5 ± 0.3%. The results of the measurements are predicted by the Landau theory of a Fermi liquid, the velocity change and the temperature dependence of the attenuation coefficient at low temperatures being explained by the propagation of a new mode of sound, called zero sound. The velocity change is in quantitative agreement with the theory. The attenuation of zero sound is about 35% larger than that predicted by theory, but could be explained by a shorter collision time between quasiparticles in the zero sound regime. The frequency and temperature dependence of the attenuation coefficient at higher temperatures are those predicted for ordinary hydrodynamic sound. (auth)

3762 (COO–1198-392) DILUTE SOLUTIONS OF ^{3}He IN ^{4}He AT LOW TEMPERATURES. Pines, David; Wheatley, John C. (Illinois Univ., Urbana). Oct. 4, 1966. Contract AT(11-1)-1198. 33p. (CONF-660816-7). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 10th International Conference on Low Temperature Physics, Moscow, USSR.

Measurements were made at saturated vapor pressure of the heat capacity of dilute solutions of concentrations 1.3% and 5.0% ^{3}He down to temperatures well below 10 m°K. No evidence for phase separation was observed. The idea that the ^{3}He quasiparticles in the ^{4}He at low temperatures constituted a weakly interacting Fermi fluid was confirmed. Results of the measurements are described. (M.O.W.)

3763 (COO–1569-5) CURRENT-CARRYING STATES OF WEAKLY COUPLED SUPERCONDUCTORS. Goldman, A. M.; Kreisman, P. J. (Minnesota Univ., Minneapolis. Cosmic Ray Group). Sept. 1966. Contract AT(11-1)-1569. 4p. (CONF-660816-6). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 10th International Conference on Low Temperature Physics, Moscow, USSR.

Weakly coupled superconductors have been shown to be capable of sustaining quantized persistent currents, which under certain circumstances have long lifetimes. Earlier work was extended to the point where the observed current levels of weakly coupled superconductors may be quantitatively compared with theory. In particular, the dependence of the ring current level structure on temperature, through the temperature dependence of both the penetration depth and the maximum zero-voltage Josephson current, can be explicitly displayed. Preliminary results are described. (M.O.W.)

3764 (MLM–1363J) DEVIATIONS FROM THE WEBER-SCHMIDT EQUATION FOR THERMOMOLECULAR PRESSURE DIFFERENCE OF ^{3}He AND ^{4}He. McConville, G. T.; Watkins,

R. A.; Taylor, W. L. (Mound Lab., Miamisburg, Ohio). Aug. 1966. Contract AT-33-3-GEN-53. 5p. (CONF-660816-5). DTIE.

From 10th International Conference on Low Temperature Physics, Moscow, USSR.

Several investigators have made measurements which are in agreement with the Weber–Schmidt expression. Other measurements show significant deviations from the Weber–Schmidt expression. It was found that these deviations can have significant effects on vapor pressure determinations in ^{3}He thermometry. An investigation is described which was started to see if some physical measuring could be attached to the four empirical constants appearing in the differential form of the Weber–Schmidt equation. (W.D.M.)

3765 (N-66-29346) FREEZING OF CRYOGENIC LIQUIDS WHEN EXPANDED TO PRESSURES BELOW THE TRIPLE POINT PRESSURE. Holmstead, G. M. (General Dynamics/Astronautics, San Diego, Calif.). Aug. 27, 1963. Contract NAS3-3232. 63p. (NASA-CR-60325; GDA/A-63-0832). CFSTI $3.00 cy, $0.65 mn.

Two experimental studies are reported. The first is concerned with photographically recording the freezing phenomena associated with an expansion to pressures below the triple point using various mockups of actual Centaur hardware. The second study deals with flow characteristics of liquid hydrogen and nitrogen through simulated micrometeorite punctures in 0.010-in. thick stainless steel into a pressure environment below the triple point pressure. The coefficient of discharge associated with incompressible ideal fluid flow was measured and the effect of liquid freezing on the flow was evaluated. Results of each study are given independently. Most of the results were obtained via high speed 16 mm movie film. A listing of the film record and its location is given for each test block. Specific scenes are included to give an indication of what is contained in the film record. A thermodynamic analysis was made of the freezing phenomena to provide quantitative concurrence with that which was observed. The appendix contains the analysis along with development problems encountered with the micrometeorite puncture leakage study test fixtures. (auth)

3766 (N-66-29908) INVESTIGATION OF SUPERCURRENT INSTABILITIES IN TYPE II SUPERCONDUCTORS. Quarterly Progress Report No. 1. (Atomics International, Canoga Park, Calif.). May 13, 1966. Contract NAS8-20552. 21p. (NASA-CR-76060; AI-66-87). CFSTI $3.00 cy, $0.65 mn.

Samples of Ti–Nb were annealed 3 hours at 800°C, rapidly cooled to retain the beta phase, and reannealed at from 400° to 550°C to initiate transformation. Light photomicrographs of samples before and after the transformation anneal are shown. After 24 hours at 450°C, particles appear in the matrix and on grain boundaries. A sample annealed 2 hours at 500°C contains what is probably equilibrium alpha phase that has nucleated at grain boundaries. Electron microscope samples were prepared from bulk samples by chemically or electrolytically thinning. Electron diffraction patterns are obtained for each photomicrograph to orient the foil and to solve the crystal structure of the precipitating phase. Precipitation in samples annealed at 400°, 450°, and 500°C gave particle densities of 10^{15} cm^{-3} for the first two temperatures and 10^{14} cm^{-3} for the latter; average particle sizes were 500, 1500, and 2000 Å, respectively. Alloy samples were rolled to a 2:1 reduction after rapidly cooling from an 800°C anneal. The deformation caused the metastable beta phase to transform. The untransformed volume probably was not severely deformed. Subsequent annealing at 350° to 500°C produces further transformation. Light microscopy offers little insight into the complexities of this process. (STAR)

3767 CRYOGENIC IRRADIATION TESTING. Smith, E. T. (General Dynamics Corp., Fort Worth, Tex.). Cryog. Eng. News, 1: No. 13, 20-3; 25(Nov. 1966).

In experiments at Fort Worth, material specimens and electrical and mechanical components having potential space applications are exposed to various combinations of radiation, vacuum, and cryogenic environments. Effects of these environments on the mechanical and physical properties of materials, and on operating characteristics of components, are determined. The data are then evaluated and used as the basis for design of equipment or as a qualification of specific components. The facility setup is described and illustrations are given of some of the test equipment. (W.D.M.)

3768 MOTION AND PINNING OF FLUX IN SUPERCONDUCTING VANADIUM FOILS, STUDIED BY MEANS OF NOISE. van Ooijen, D. J.; van Gurp, G. J. Philips Res. Rep., 21: 343-67(Oct. 1966).

The power spectra of the voltage fluctuations across superconducting vanadium foils were measured. These fluctuations arise if in the mixed state a transport current flows. A simple theory for shot noise applied to the model of a viscous flow of flux bundles crossing the specimen is put forward. The measured power spectra are in quantitative agreement with the theoretical predictions. Apart from an independent determination of the transit time, which was also known from dc measurements and ranged from 0.5 to 10 milliseconds, the noise measurements also yielded the number of flux quanta contained by the flux bundles. This number was found to decrease from about 10^5 at low current densities and strong pinning to 1 at high current densities and weak-pinning conditions. Deviations from the theoretical behavior of simple shot noise could be explained by the presence of a fraction of pinned vortices not taking part in the motion. At high current densities often a second type of noise was found resembling flicker noise. (auth)

3769 HIGH-FIELD SUPERCONDUCTING MAGNETS. Sampson, W. B. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.) Trans. Magnet., MAG-2: 338(Sept. 1966).

Use of superconducting materials for the construction of superconducting magnets is briefly reviewed. Greater understanding of the effects of magnetic and thermal transients has resulted in the use of normal materials of high conductivity to stabilize the magnet windings so that it is now possible to construct coils with fields and volumes limited only by the basic structural and superconducting properties of the materials used. Concurrent with these developments the production of better stabilized and more easily handled Nb_3Sn conductors has raised the max field obtainable with superconductors to ~ 180 kG. Numerous large magnets are under construction at present, including one design to produce 150 kG with a 6-in. bore and a group of solenoids which will produce 75 kG in a 20-in. volume. A proposal was submitted for the building of a bubble chamber magnet with an ID of 16 ft. In the high-energy physics field where enormous amounts of power are used by conventional beam-handling magnets a promising start has been made on the development of superconducting quadrupoles and dipoles which should markedly shorten the beam paths. There is even a remote possibility that the very large accelerators of the future will be partially superconducting. (BBB)

3770 METHOD OF CORRELATION FUNCTION IN THE THEORY OF SUPERCONDUCTIVITY. II. LINEARIZED GINZBURG–LANDAU EQUATION AND DIFFUSION APPROXIMATION. Lueders, Gerhart (Univ., Goettingen, Ger.). Z. Naturforsch., 21a: 1415-25(Sept. 1966). (In German).

The method of correlation function is, without complete justification, extended to superconductors in the presence of a magnetic field. Applying this method, the linearized and generalized Ginzburg–Landau equation and de Gennes' diffusion approximation are derived in a simple way. The results agree with those obtained previously by de Gennes, Gorkov, Maki, Tewordt, and others. In special cases (no magnetic field, pure superconductor or isotropic scattering) they can also be derived from Werthamer's kernel. In connection with this kernel, the limits of validity of both the linearized and generalized Ginzburg–Landau equation and of the diffusion approximation are discussed. (auth)

3771 METHOD OF CORRELATION FUNCTION IN THE THEORY OF SUPERCONDUCTIVITY. III. DERIVATION OF THE BOLTZMANN EQUATION. Lueders, Gerhart (Univ., Goettingen, Ger.). Z. Naturforsch., 21a: 1425-36(Sept. 1966). (In German).

The Boltzmann equation, which was conjectured and applied in previous papers of this series, is derived from an integral equation given by Edwards, Abrikosov, and Gorkov. The quasi-classical approximation for the calculation of Green functions is presented. (auth)

3772 HYDRODYNAMIC EQUATIONS AND THE ELEMENTARY EXCITATIONS IN FLUIDS. Galasiewicz, Z. (Univ., Wroclaw). Acta Phys. Pol., 30: 567-76(Oct. 1966).

The hydrodynamic equations with "density sources" are obtained for the Bose and Fermi systems. After solving the linearized hydrodynamic equations the expressions for the retarded, thermodynamical Green's functions are obtained in the long-wavelength low-frequency domain. Damping phenomena are taken into account. (auth)

3773 EFFECTS OF ENERGY GAP ANISOTROPY IN PURE SUPERCONDUCTORS. Clem, John R. (Univ. of Illinois, Urbana). Contracts DA-31-124-ARO(D)-114; AF 735-65. Ann. Phys. (N. Y.), 40: 268-95(Nov. 1966).

Various effects of anisotropy of the superconducting energy gap are theoretically considered. In order to estimate the effects of anisotropy upon the thermodynamic properties of pure, single-crystal superconductors, a factorable BCS-like model for the effective electron–electron matrix element $V_{pp'} = (1 + a_p)V$

$(1 + a_{p'})$ is used. The effects of anisotropy upon the temperature dependence of the gap parameter, the critical field, and the specific heat near the critical temperature are then shown to be small and proportional to the mean-squared anisotropy $\langle a^2 \rangle$, which is of the order of 0.02 for typical superconductors. Theoretical expressions which explicitly include the anisotropy of a general gap parameter are given for low-temperature specific heat, nuclear spin–lattice relaxation time, tunneling, surface resistance, and longitudinal ultrasonic attenuation. These processes are seen to be more sensitive to the details of the anisotropy than are the above thermodynamic properties. (auth)

3774 ON THE CHANGE IN TRANSITION TEMPERATURE OF DIFFERENT SUPERCONDUCTORS THROUGH ELECTRON EXTRACTION. Ruehl, W. (Physikalisch-Technische Bundesanstalt, Brunswick). Z. Phys., 196: 464-76(1966). (In German).

The growing of oxide layers on pure metal films at low temperatures may be explained by acceptor levels at the oxide–oxygen interface. These surface states produce an electric field of high strength by extracting about 10^{15} electrons per cm^2 out of metal film. As had been shown in earlier experiments, this capturing process shifts the superconducting transition temperature to higher values for the trivalent metals Al, In, and Tl and to lower values for the tetravalent metals Sn and Pb. Extended studies on Tl show that this change in transition temperature is proportional to the relative decrease of the electron density in the metal film. The constant of proportionality has the value $k_{Tl} = -4.4°$. With reasonable assumptions, this constant could be determined for Sn too: $k_{Sn} = 7.9°$. These values agree quantitatively with the results of Glover and Sherill who investigated the charge effect on superconductors by a condenser method. They also fit the data calculated by Ginsberg from experimental results on superconducting compounds with his extension of the theory of Markowitz and Kadanoff. (auth)

3775 WIDTH OF THE HOMOGENEITY REGION OF INTERMETALLIC PHASES IN THE Nb–Sn AND V–Ga SYSTEMS. Kogan, V. S.; Lazarev, B. G.; Matsakova, A. A.; Ovcharenko, O. N.; Yakimenko, L. F. (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Fiz. Metal. Metalloved., 21: 828-32(June 1966). (In Russian).

Experiments were made to determine the width of the homogeneity region of intermetallic phases formed in the Nb–Sn and V–Ga systems, i.e., systems whose components have widely different melting temperatures. Nb_3Sn and V_3Ga intermetallic compounds were obtained by diffusion of Nb_3Sn by holding an Nb specimen for several hours in molten tin at 1000°C, and V_3Ga by holding a vanadium specimen wetted with gallium in a vacuum at about 1200°C. X-ray-diffraction patterns of the diffusion layer on vanadium showed that the surface layer contacting gallium and the inner layer adjacent to vanadium had equal lattice parameters, 4.819 ± 0.002 Å. The temperature of transition to the superconducting state of V_3Ga was found to be 14.44°K with a transition zone width of 0.2°K. These data confirmed that the diffusion zone consisted only of V_3Ga of stoichiometric composition. Similar results were obtained for Nb_3Sn. The layers adjacent to Sn and Nb had the same lattice parameters, equal to 5.288 ± 0.001 Å, which showed that the homogeneity region of Nb_3Sn is also very narrow. A wide homogeneity region reported in some earlier works for the refractory metal-rich phases in alloys whose components have widely different melting temperatures is presumably a result of tested alloys being in nonequilibrium state owing to a low diffusion rate of these phases. (ATD)

3776 COHERENT RADIATION FROM VOLTAGE-BIASED WEAKLY CONNECTED SUPERCONDUCTORS. Zimmerman, J. E.; Cowen, J. A.; Silver, A. H. (Ford Motor Co., Dearborn, Mich). Appl. Phys. Lett., 9: 353-5(Nov. 15, 1966).

The generation of coherent radiation with voltage-biased superconducting point contacts at both 30 MHz and 10 MHz is reported. The method of voltage biasing stabilizes the frequency of the emitted radiation against external noise sources and is tunable over a wide frequency range. The electromagnetic coupling of the superconducting generator to the receiver was optimized, and at least 5% of the generated power at 30 MHz was detected. The relation $V = \Phi_0 \nu$, where Φ_0 is the flux quantum, is satisfied. Furthermore, harmonics, $V = n\Phi_0\nu$, and subharmonics, $nV = \Phi_0\nu$, of this relation were observed. The frequency stability of the emitted radiation was limited by the stability of the bias supply and was measured to be 10^{-5} at 30 MHz. (auth)

3777 THE DISTRIBUTION LAW OF THE MAGNETIC FIELD IN A TYPE II SUPERCONDUCTOR. Dobrosavljevic, Ljiljana (CNRS, Orsay, France). Compt. Rend., Ser. B, 263: 502-4(Aug. 17, 1966). (In French).

In the Schubnikov phase, the magnetic field distribution p(h) has three singularities. It has discontinuities at the nodes h_{min} and h_{max}, and a single logarithmic singularity h_s. The values of these fields are calculated for an applied field H neighboring the upper critical field H_{c2} by means of the Landau–Ginsburg equations. (tr-auth)

3778 SUPERCONDUCTIVITY OF TECHNETIUM AND TECHNETIUM CARBIDE. Giorgi, A. L.; Szklarz, E. G. (Los Alamos Scientific Lab., N. Mex.). J. Less-Common Metals, 11: 455-6 (Dec. 1966). (LA-DC-8059).

Technetium metal was purified by converting it to ammonium pertechnate, recrystallizing, and reducing to the metal by heating in a hydrogen atmosphere. Magnetic susceptibility measurements were used to determine the superconducting transition temperature. The transition occurred at 7.92°K over a temperature range of 0.02°K. Technetium carbide prepared from the purified metal was found to be superconducting with a transition temperature of 3.85°K. (A.G.W.)

3779 SOME SURFACE CURRENT PHENOMENA IN TYPE-II SUPERCONDUCTORS. Ullmaier, H. A.; Gauster, W. F. (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 37: 4519-21(Nov. 1966). (ORNL-P-2172).

For a cylindrical sample of an imperfect type-II superconductor in an external field H_{ext} parallel to its axis, it is found that in the mixed state no flux enters or leaves the specimen within an interval $H_{ext} \pm \Delta H$; the positive or negative sign applies when H_{ext} is reached in a decreasing or increasing field, respectively. Similarly, when the sample is cooled in a field H_{ext}, an increase of the external field less than ΔH does not change the trapped flux. ΔH depends only on H_{ext} and not on B, the bulk flux density, which itself depends on the magnetic history of the specimen and its defect structure (flux pinning, bulk critical current). ΔH is affected by various surface treatments, such as machining and chemical polishing, but not significantly by metal plating. The results can be explained in terms of an intrinsic surface critical current, and comparison with existing theoretical calculations yields reasonable agreement. (auth)

3780 NORMAL COMPONENT DENSITY IN CONCENTRATED HELIUM ISOTOPE SOLUTIONS. Grigorev, V. N.; Eselson, B. N.; Malkhanov, V. P.; Sobolev, V. I. (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Zh. Eksp. Teoret. Fiz., 51: 1059-63(Oct. 1966). (In Russian).

The density of the normal component of concentrated helium isotope solutions is measured by the oscillating disc-pile technique at temperatures ranging from the λ point of the solution down to 1.45°K. For solutions containing up to 15.5% of ^3He and temperatures not exceeding 1.6°K a linear dependence of the normal component density on weight concentration is found to hold. For solutions containing 21.7% ^3He deviations from linearity are observed towards smaller values of the normal component density. The ^3He effective mass thus derived (2.35 masses of ^3He atoms) is in agreement with the data of other authors. (auth)

3781 LOW-FIELD MAGNETIC BEHAVIOR OF TYPE-II SUPERCONDUCTORS. del Castillo, G.; Fast, R. W. (Midwestern Universities Research Association, Stoughton, Wis.). J. Appl. Phys., 37: 4597-8(Nov. 1966).

Flux penetration in type-II superconductors was investigated by measuring the magnetic induction in the gap between two parallel superconducting plates oriented normally to an external field. Two distinct modes of flux penetration were observed for rates of increase of the external field between 0.25 and 144 G/sec: the penetration was continuous for Nb–Zr and Lipowitz metal, while for Nb_3Sn and Nb–Ti it proceeded by flux jumps. The mode for a particular material did not depend on the rate of change of the field. A 180° rotation indicated no connection between the flux pattern and possible material imperfections. (A.G.W.)

3782 FLUX JUMPS IN A HARD SUPERCONDUCTOR IN SUPERIMPOSED AC AND DC MAGNETIC FIELDS. Gandolfo, David A.; (RCA Applied Research, Camden, N. J.); Harper, Charles M.; Hecht, R. L. J. Appl. Phys., 37: 4582-3(Nov. 1966).

Cylindrical tubes of cold-worked Nb–50% Ti alloy were used to study flux jumps in hard superconductors in superimposed ac and dc magnetic fields. Observations were made with ac fields ranging in frequency from 6.3 to 2100 cps with peak amplitudes up to 2200 G and in dc fields of 2 to 30 kG. No signal reached a Hall effect probe in the interior of the sample when an ac field of less than a threshold value was applied. When the field exceeded this threshold, a relatively large signal was detected by the probe. For a given frequency, the flux jumps occurring at the threshold were identical in amplitude and occurred regularly. The field required to cause an ac signal to penetrate to the interior of the sample was inversely proportional to the frequency. A related experiment indicated that the flux penetration effects were occurring without a

gross increase in temperature throughout the bulk of the sample. (A.G.W.)

3783 FOURTH SOUND VELOCITY IN ^{3}He–^{4}He SOLUTIONS. Eselson, B. N.; Dyumin, N. E.; Rudavskii, E. Ya.; Serbin, I. A. (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Zh. Eksp. Teoret. Fiz., 51: 1064-70 (Oct. 1966). (In Russian).

The expression for the velocity of fourth sound in ^{3}He–^{4}He solutions derived previously for weak solutions is extended to the case of high concentrations. The relative oscillations of pressure, temperature and solution concentration in the fourth sound wave are calculated. The calculations are valid for temperatures and concentrations at which ^{3}He is involved only in normal motion. The temperature and concentration dependences of the fourth sound velocity in helium isotope solutions are investigated experimentally for solutions containing 6.30, 11.05, 15.56 and 19.53 mol. % of ^{3}He. The agreement between the experiments and theory is satisfactory whence it is concluded that in solutions of the concentrations studied ^{3}He is involved only in normal motion. It is shown that the density of the superfluid component of a solution in a narrow channel is identical with that for a macroscopic volume. (auth)

3784 SURFACE ELECTRIC FIELD ON A SUPERCONDUCTING WIRE CARRYING AN AC TRANSPORT CURRENT IN AN EXTERNAL MAGNETIC FIELD. Grasmehr, T. W.; Finzi, L. A. (Carnegie Inst. of Tech., Pittsburgh). IEEE (Inst. Elec. Electron. Eng.) Trans. Magnet., MAG-2: 334-7 (Sept. 1966).

The penetration of magnetic fields in nonideal type-II superconducting wires carrying audio-frequency transport current with a transversally applied static magnetic field was investigated measuring the E field along the surface of straight segments of 10-mil-dia Nb–25% Zr wire. Oscillographic responses obtained for various frequencies, current amplitudes, and distances between potential probes are described. The application of a limited-current-density model employed by others for different geometries and forms of excitation to the case of a wire carrying a transport current in an external field is discussed. The oscillographic responses are shown to agree with analytical calculations based on the model, provided that some recognition is given to the magnetic field dependence of the current density parameter. (BBB)

3785 PROSPECTS FOR THE EMPLOYMENT OF SUPERCONDUCTORS IN ALTERNATING MAGNETIC FIELDS. Wilkinson, K. J. R. (Associated Electrical Industries, Rugby, Eng.). IEEE (Inst. Elec. Electron. Eng.) Trans. Magnet., MAG-2: 367-74 (Sept. 1966).

Because of their complete diamagnetism, soft superconductors can only be used, whether with alternating or direct current, as boundaries to magnetic flux. This prevents their application wherever the magnetic flux-density in which they are immersed or to which they give rise exceeds a characteristic critical level. The highest level occurs with niobium at about 1500 G. But the windings of conventional transformers already work with densities of 2600 G at their rated load and materially exceed this under fault conditions. The same difficulty applies to the conductors of cables used in high-power transmission. Loss expressions are presented and a discussion is conducted in terms of a 570-MVA generator transformer and of a 760-MVA 275-kV 3-phase cable feeder. It is concluded that no economic case can be made for the employment of superconductive materials in either transformers or cables. (BBB)

3786 MAGNETIC LOSSES IN SUPERCONDUCTORS AT HIGH FREQUENCIES. Haden, C. R. (Univ. of Oklahoma, Norman); Hartwig, W. H.; Victor, J. M. IEEE (Inst. Elec. Electron. Eng.) Trans. Magnet., MAG-2: 331-3 (Sept. 1966).

Magnetic losses in superconductors at radio frequencies are analyzed in terms of a simple model for energy dissipation at local flux-trapping centers. A mathematical development shows that the effective surface resistance is proportional to frequency, the field penetration depth, the density of trapping sites, and a threshold function of the maximum rf. Experimental data are obtained through rf pulse measurement of the quality factors of superconductive resonant circuits, having resonant frequencies near 100 Mc. Decay curves for the energy output of these circuits show a marked break or increase in quality factor at low-field levels. This is taken to correspond to the local critical field predicted in the model. The abruptness of the break leads to the conclusion that all of the trapping sites are of a similar nature and are probably Abrikosov fluxoids. If so, these measurements constitute the first direct observation of the transition of the fluxoid core. (BBB)

3787 A HYBRID CRYOTRON TECHNOLOGY. I. CIRCUITS AND DEVICES. Fruin, R. E.; Oka, A. K.; Bremer, J. W. (General Electric Co., Sunnyvale, Calif.). IEEE (Inst. Elec. Electron. Eng.) Trans. Magnet., MAG-2: 381-5 (Sept. 1966).

Some features of hybrid cryotron technology discussed are: Close proximity of a superconducting shield plane to the cryotron gates to ensure well-ordered magnetic fields. Formation of all gates and interconnections through stencil masks in an unbroken vacuum to give reliable integral interconnections. Photo-etching of the top circuit layer (Pb) to form narrow controls and complex interconnection geometrics. The hybrid cryotron technology is explained as an effective technique for batch fabrication of large numbers of interconnected devices. Fabrication of large arrays of active devices is made practical by the fault tolerant properties of the cryotron device and the advantages of combined stencil masking and photo-etching techniques. Several assemblies were given extensive operational and temperature cycling. These assemblies included 5 substrate cryotron computers and 4 substrate content addressed memories. Details of circuit and logic design, device characteristics, and fabrication yield are described. Present work on arrays of 10,000 interconnected devices on a single substrate is reported. Fabrication yields of 99.98% and time constants of 10 nsec are expected in the near future in arrays of this size through improvements in fabrication process control and device utilization. (BBB)

3788 DESIGN OF LARGE CRYOTRON MEMORIES. Richards, N. D. (Mullard Research Labs., Redhill, Eng.). IEEE (Inst. Elec. Electron. Eng.) Trans. Magnet., MAG-2: 394-8 (Sept. 1966).

To improve the operating range of superconducting continuous film memories, understanding of the processes involved in half-select disturbs is essential. Some experiments can no longer be explained by the use of a model based upon an equivalent circuit with lumped constants, and a model taking into account the surface distribution of the currents is required. Two basically different modes of disturbs are considered: In the first mode a spurious reading of the stored flux is triggered by the half-select current when this current exceeds a certain threshold; in the second, only a limited decay of the stored energy takes place without any change of the stored flux, so that no sense signal is induced. It was found that the relative importance of the two disturb modes for a given geometry is closely related to the material structure of the memory plane and can be changed by proper action upon the deposition parameters. By proper choice of cell configuration and material structure, cells were obtained with fairly large operating ranges. These cells were used to build a memory plane of 1024 bits capacity. (BBB)

3789 A HYBRID CRYOTRON TECHNOLOGY. II. FABRICATION. Adams, C. N.; Bremer, J. W.; Oka, A. K.; Ummel, M. L. (General Electric Co., Sunnyvale, Calif.). IEEE (Inst. Elec. Electron. Eng.) Trans. Magnet., MAG-2: 385-9 (Sept. 1966).

A hybrid thin-film cryotron fabrication technology utilizing a combination of stencil masking and photo-etching methods to achieve high-density (100 active devices per cm^2) arrays of interconnected active devices is described. Stencil masks are used to delineate the superconducting shield plane, cryotron gates, some interelement connections, and intercircuit insulation. Photo-etching is used to form the uppermost layer of the cryotron array. This uppermost layer contains the most dimensionally critical segments of the circuit, the cryotron control elements and the remainder of the device-to-device interconnections. Fabrication equipment was developed for prototype manufacturing. Cryogenic test data collected from over 100 cryotron arrays, containing 1863 active interconnected devices per substrate, show that this hybrid fabrication process is consistently capable of producing substrates with elemental yields in excess of 99.9%. Substrates containing in excess of 10,000 active interconnected devices are now entering design, fabrication, and test. (BBB)

3790 PURE-METAL AC WINDINGS FOR USE AT CRYOGENIC TEMPERATURES. Burnier, P. H.; Pouillange, J. P. (Advanced Research Dept., Alsthom, Paris). IEEE (Inst. Elec. Electron. Eng.) Trans. Magnet., MAG-2: 375-80 (Sept. 1966).

The use of superconductors presents entirely new conditions in the design of transformer windings. Because of the very large mean free path of electrons, a few parasitic effects of resistivity can no longer be neglected: size effects determine the minimum thickness of the conductors, magnetoresistive effects are much less adverse with ac fields than with dc fields. As regards the low value of the penetration depth of electromagnetic waves, 3 types of aluminum windings with one single turn per layer were studied: (1) in wide-sheet windings the supplementary losses due to the radial field are high; (2) in transposed-band windings the proportion of supplementary losses due to the radial field is reduced to 110% if the width of the strips is 0.4 mm; (3) in perfectly transposed windings an increase in length of the conductors must be accepted. This increase and the radial field result in additional losses of 90% for the same width of strips of 0.4 mm. (BBB)

3791 REALIZATION OF AN IRON-FREE SUPERCONDUCTING QUADRUPOLE LENS. Septier, A. (Faculte des Sciences, Orsay, France); Mouza, J. C.; Donadieu, L. IEEE (Inst. Elec. Electron. Eng.) Trans. Magnet., MAG-2: 326-30(Sept. 1966).

It is shown that it is possible to realize, by means of coils, field configurations with quadrupolar symmetry in which the transverse field gradient remains constant to ca 10^{-3} in the useful central zone, thus permitting the realization of quadrupole lenses with good optical qualities. Optimum values >1% were calculated for geometrical parameters leading to linearity of the field gradient. Two cases were studied: trapezoidal-cross-section coils with saddle-shaped extremities, and rectangular-cross-section plane coils. In spite of greater construction difficulties, a quadrupole magnet of the first type was realized using Nb–Zr multicored cable. It has a useful dia of 5.2 cm, mechanical length of 16 cm, and an equivalent magnetic length of 19.2 cm. The maximum field gradient obtained is 7000 G cm^{-1}, the current being I = 232 A. But the value of the stable working intensity is 225 A, giving a field gradient of 6800 G cm^{-1}. The radial variations of the field are perfectly linear and in good agreement with theoretical results. It is suggested that bigger quadrupole lenses can be designed with even higher field gradients, taking advantage of the improvements of new superconducting materials (e.g., with Nb–Ti cables or Nb_3Sn ribbons) and using relatively thicker windings and external iron cylindrical shields. (BBB)

3792 SURFACE INSTABILITIES IN TYPE-II SUPERCONDUCTORS. Rollins, R. W.; Silcox, J. (Cornell Univ., Ithaca, N. Y.). Phys. Lett., 23: 531-2(Nov. 28, 1966).

In response to a small low-frequency ac field superimposed upon a large dc field, small flux jumps are observed to occur only during the half cycle corresponding to flux flowing out of a type-II superconductor when in the mixed state. An explanation is proposed based on the thermal effects of the flow, creation, and annihilation of flux vortices. (auth)

3793 DE HAAS–VAN ALPHEN OSCILLATIONS IN THE CRITICAL TEMPERATURE OF TYPE-II SUPERCONDUCTORS. Rajagopal, A. K. (Univ. of California, Riverside); Vasudevan, R. Phys. Lett., 23: 539-40(Nov. 28, 1966).

An exact solution of the linearized gap equation is given when the quantization of electrons in a constant magnetic field is obtained. From this the previous calculation of the present authors is recovered and the De Haas–Van Alphen oscillations in the critical temperature of a type-II superconductor are derived. (auth)

3794 λ TRANSITION AT THE LOWER CRITICAL FIELD IN TYPE-II SUPERCONDUCTORS. Mueller-Hartmann, E. (Univ., Cologne). Phys. Lett., 23: 521-3(Nov. 28, 1966).

Abrikosov's physically intuitive ansatz of superposing free flux lines in order to calculate the mixed state of type-II superconductors at the lower critical field is shown to be mathematically exact for all $\kappa > \frac{1}{2}\sqrt{2}$ in the framework of Ginzburg-Landau theory. (auth)

3795 DERIVATION OF GINZBURG–LANDAU EQUATIONS FOR STRONG-COUPLING SUPERCONDUCTORS. Menyhard, N. (Central Research Inst. for Physics, Budapest). Nuovo Cimento (10), 44B: 213-17(July 11, 1966).

The consequences of using a general nonlocal two-particle interaction in the derivation of the equations for local superconductors in a magnetic field were examined earlier. A similar investigation was made, starting from the equations of the coupled electron-phonon system, which are more adequate for the description of strong-coupling superconductors. It is shown that if the electron-phonon coupling matrix element $g_{p,p',\lambda}$ is supposed to depend only on the electron momentum transfer p-p', and phonon polarization λ, the Ginzburg–Landau equations result with parameters differing from those derived by Gorkov. However, if the dependence of $g_{p,p',\lambda}$ on p + p' cannot be neglected, which turns out to be the case if the Fermi surface is far from spherical, no order parameter satisfying the Ginzburg–Landau equations can be defined, and instead of them one gets coupled equations determining the self-energy parts and the magnetic potential. (M.O.W.)

3796 INVESTIGATION OF THE MAGNETIC PROPERTIES OF DOUBLE-BAND SUPERCONDUCTORS IN THE VICINITY OF THE UPPER CRITICAL FIELD. Moskalenko, V. A. (Inst. of Mathematics and Computer Tech., USSR). Zh. Eksp. Teoret. Fiz., 51: 1163-75(Oct. 1966). (In Russian).

The fundamental electrodynamic equations for double-band superconductors are formulated. The magnetic properties of pure double-band superconductors in the neighborhood of H_{c2} ($H_c \lesssim H_{c2}$) are investigated in the almost free electron approximation. An expression is derived for the free energy of the system in a second approximation with respect to the difference between H_{c2} and magnetic induction B. Other magnetic characteristics are investigated on this basis. It is shown that double-band superconductors of the second kind can be characterized by two constants $\varkappa_1$ and $\varkappa_2$ which exceed $1/\sqrt{2}$. Consequently, the free energy is not, generally speaking, a monotonous function of the mixed state theory parameter σ and hence the lowest value of σ (σ > 1) is not always realized in such superconductors, in contrast to the single band case. For superconductors with large nonmagnetic impurities the fundamental equations acquire a single band nature, the critical temperature T_c and parameter $\varkappa$ of the Ginzburg–Landau theory being correspondingly defined on the double-band basis. (auth)

3797 A STUDY OF SUPERCONDUCTING HIGHLY HOMOGENEOUS MAGNETS FOR NUCLEAR AND ELECTRONIC RESONANCE. Sauzade, M.; Girard, B.; Pontnau, J.; Lesas, P. (Faculte des Sciences, Orsay, France). IEEE (Inst. Elec. Electron. Eng.) Trans. Magnet., MAG-2: 323-6(Sept. 1966). (In French).

The magnet for nuclear resonance is a sixth-order solenoid with a 4.5-cm room temperature access. The maximum field obtained is 58 kG with an homogeneity of 5×10^{-7} in 2 cm^3. Computation was made using Garrett's method with an electronic computer. The dimensions were optimized in order to obtain a sixth-order field with a minimum weight of superconducting wire. They are length 338 mm, ID 65.5 mm, and OD 161 mm. This solenoid is wound with a single wire of superconducting alloy, Nb–Zr. The measured inductance of the solenoid is 300 H and at maximum field it stores an energy of around 45,000 J. Good results were obtained with this magnet on the protons in high-resolution nuclear magnetic resonance at 180 MHz. The magnet for electronic resonance is simple solenoid wound with a 7-strand cable in Nb–Zr alloy. Its dimensions are length 20.7 cm, ID 2.22 cm, and OD 9.42 cm, and the field homogeneity is 10^{-4} in one cm^3. This magnet provides the field for a 2-mm wavelength electronic spectrometer. With this spectrometer, transition was observed between fundamental levels of trivalent vanadium ion in Al_2O_3 at 4.2°K and, by this means, the g factor and the zero field splitting of this ion were accurately determined. (BBB)

3798 VERTICAL TEMPERATURE GRADIENT IN THE FLUID- AND VAPOR-PHASE OF He IN A CYLINDRICAL RESERVOIR. Schmidt, D.; Keck, K.; Schubert, G. U. (Univ., Mainz). Z. Angew. Phys., 21: 532-5(1966). (In German).

The vertical temperature gradient in liquid helium and in the vapor phase is measured by means of a resistant thermometer. The temperature gradient is compared with that one which will result from the evaporation curve if the hydrostatical pressure of the liquid is added to the pressure above surface of liquid helium. Especially the distribution of temperature as dependent upon the material used for the cryostat is examined. (auth)

3799 CRYOSTATS. Webb, F. J. (to U. S. Atomic Energy Commission). U. S. Patent 3,271,966. Sept. 13, 1966.

A cryostat that is automatically vented so as to make necessary the refilling of the cryostat only at fairly long intervals is described. Gas is evolved near the bottom of the cryostat due to the passage of heat from the ambient atmosphere onto the cryostat. This raises the level of the cooling fluid in the cryostat automatically to open a valve to vent the gas and thereby to close the valve for the collection and release of gas again at periodic automatically controlled intervals. (AEC)

Plasma and Thermonuclear Physics

Confinement and Heating of Plasma

Refer also to abstract 3961.

3800 (CLM-R-62) FAST HIGH-VOLTAGE Z PREIONIZATION OF A MEGAJOULE THETA PINCH. Newton, A. A. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). July 1966. 10p.

Dep. mn. BIS $0.50. HMSO 2s. 6d.

The impurities in theta pinch plasmas are found to originate from the interaction of the pre-ionized plasma with the tube wall when the theta pinch bank is switched on. An improved pre-ionizer is described which reduces the concentration of oxygen in the final plasma by minimizing the wall contact in the early stages. The conditions necessary for increased purity result in less-efficient magnetic compression of the plasma. Various Z-preionization schemes are compared by observing their effect on the diamagnetism of the final plasma. (auth)

3801 (LA-3596) ANTICIPATED SCYLLA IV EXPERIMENTS PERTAINING TO SCYLLAC. Ribe, F. L.; Quinn, W. E. (Los Alamos Scientific Lab., N. Mex.). Aug. 31, 1966. Contract W-7405-eng-36. 17p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Experiments to be performed on the Scylla IV device which relate to the proposed Scyllac device are described. One group of experiments consists of tests of certain engineering features. A second class of experiments involves studies of plasma stabilization concepts which arise in making a toroidal theta-pinch plasma. These include studies of a "static" bumpy cylindrical plasma, the feasibility of dynamical stabilization techniques, and plasma drift in a curved coil with static stabilization fields. (auth)

3802 (ORNL-P-2614) A METHOD FOR INTRODUCING ENERGY SPREAD IN INJECTION MACHINES. Edwards, Randall S.; Postma, Herman (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 19p. (CONF-661016-29). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Symposium on Engineering Problems of Controlled Thermonuclear Research, Gatlinburg, Tenn.

Theory predicts that certain microinstabilities in the DCX-1 machine can be suppressed by introducing a sufficient spread in the energy distribution of the trapped ions. A method of producing this energy spread is described. The equipment and its performance as applied to the plasma of the DCX-1 experiment are described. (M.O.W.)

3803 (ORNL-P-2640) IRON-CORE MINIMUM "B" MAGNET. Halchin, W.; Alexeff, I. (Oak Ridge National Lab., Tenn.). [nd]. Contract W-7405-eng-26. 9p. (CONF-661016-23). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Symposium on Engineering Problems of Controlled Thermonuclear Research, Gatlinburg, Tenn.

The design of an iron-core magnet for producing a "minimum-B" magnetic field is given. Typical field measurements are included. (M.O.W.)

3804 (ORNL-P-2642) INVESTIGATION OF MATERIAL FAILURES IN DCX-1 LINER. Leonard, W. J. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 17p. (CONF-661016-24). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Symposium on Engineering Problems of Controlled Thermonuclear Research, Gatlinburg, Tenn.

A brief discussion of the liner materials of the DCX-1 machine is presented. The material failures and the nature of these defects are discussed. (M.O.W.)

3805 (ORNL-P-2669) CW MICROWAVE SYSTEMS FOR ELECTRON-CYCLOTRON HEATING EXPERIMENTS. Eason, H. O. Jr. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 19p. (CONF-661016-22). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Symposium on Engineering Problems of Controlled Thermonuclear Research, Gatlinburg, Tenn.

A general discussion is presented on the various cw microwave systems presently being used for plasma heating. The equipment and its operation are discussed. (M.O.W.)

3806 (ORNL-P-2671) RIBBON COILS FOR HIGH CURRENT DENSITIES. Luton, J. N. Jr. (Oak Ridge National Lab., Tenn.). [1965]. Contract W-7405-eng-26. 18p. (CONF-661016-25). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Symposium on Engineering Problems of Controlled Thermonuclear Research, Gatlinburg, Tenn.

Spiral coils wound of grooved copper strips and interleaved with insulating strips are described. The arrangements are such that the coolant grooves can be equally spaced without interfering with the ability of the coil winding to transmit appreciable fractions of the electromagnetic forces radially outward to mechanical structural members. The resulting simplification of construction gives coils which are quite economical. Current densities in the range of 200 kamp/in^2 were achieved. The results of performance and endurance tests on several prototypes are reported. (auth)

3807 (RT-FI-(66)-3) MEASUREMENTS OF LARGE MAGNETIC FLUX DERIVATIVES BY MEANS OF A CLOSED RESISTIVE LOOP. Bartoli, C.; Gratton, R. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 10p. Dep. mn.

A method to measure magnetic flux derivatives through large areas, avoiding high voltages in the circuit, is described. A brief circuit analysis and practical construction data for a typical situation are given. (auth)

3808 (UCRL-70028) SELECTION OF A GETTER MATERIAL AND MODE OF OPERATION. Doggett, James N.; Vogtlin, George E. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 30, 1966. Contract W-7405-eng-48. 14p. (CONF-661016-19). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Symposium on Engineering Problems of Controlled Thermonuclear Research, Gatlinburg, Tenn.

An investigation was made to optimize the operation of Ti getters in the center section of the 2X Multiple Compression Experiment. The center section consists of a piece of 18-in.-dia glass pipe 13 ft long connecting end chambers 25 ft in dia by 10 ft long. The glass section has twelve 1¼-in.-dia diagnostic ports. Three of these ports along with end openings were made available for getters. Three materials were tested: Ti wound on W cable, a commercially wound filament, and an 85% Ti–15% Mo wire. (M.O.W.)

3809 (UCRL-70035) MAGNETIC MIRROR FIELD CONTROL IN THE ASTRON EXPERIMENT. Kippenhan, D. O. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 30, 1966. Contract W-7405-eng-48. 17p. (CONF-661016-20). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Symposium on Engineering Problems of Controlled Thermonuclear Research, Gatlinburg, Tenn.

Sixty-five SCR controlled power supplies totaling 1.5 MW feed a long solenoid; and sixty-five transistorized pulse-width modulated power supplies, totaling 200 kW, feed two cantilevered solenoids inside the long solenoid. By appropriately controlling these power supplies, any magnetic field mirror geometry can be obtained. These mirror fields are used to capture and contain a 4-MeV beam in the Astron facility. By the use of five small common reference power supplies, a potentiometer per power supply, and a computer-type program board, the maximum depth and location of mirrors can be easily changed. Five console-mounted potentiometers control five magnetic mirrors in the solenoidal magnet system. The mirror control is linear and controllable from a maximum mirror depth to no mirror or level field. (auth)

3810 HEATING OF SMALL PLASMOIDS INCIDENT ON AN AXIALLY SYMMETRIC MAGNETIC FIELD. Khizhnyak, N. A.; Vodyanitskii, A. A. pp 53-60 of Issledovanie Plazmennykh Sgustkov. Sinelnikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

This is a continuation of earlier work where it was shown that the equations of motion of a plasmoid can be represented in the hydrodynamic approximation in terms of the total current in the plasmoid and its self-induction. The heating of the plasmoid by the currents induced in it from the magnetic field is described. Since the magnetohydrodynamic equations for this case are quite complicated, the connection between the effective dimensions of the plasmoid and its thermodynamic quantities are determined under the assumption that the plasmoid has a sufficiently abrupt boundary with the vacuum and that the relaxation processes in the plasma are quite rapid and satisfy the equations of an ideal gas. The thermodynamic equations for the plasmoid are then written out on the basis of these approximations. The plasmoid is assumed spherical or spheroidal with small eccentricity. Conditions under which the plasmoid entering the magnetic field will contract or expand, and the maximum and minimum values of the temperatures reached by the plasmoid, are then determined from the derived equations for several particular cases. (ATD)

3811 WORK OF A RESEARCH LABORATORY ON PLASMA PHYSICS. Keller, Robert (Research Lab. on Plasma Physics, Lausanne, Switzerland). Ind. At., 10: No. 9-10, 69-78(1966). (In French).

The principal function of the laboratory consists in confining and heating the plasma with the aid of alternating magnetic fields of several MHz. Particularly stable configurations must be obtained, as well as a highly efficient heating. The relatively intense magnetic fields required by this method of confinement are built up by generators constructed according to a new concept which makes it possible to reach a high frequency power of 100 MW and more. The changes in the plasma are detected by means of a large number of quick diagnostic methods, certain of them still in a stage of preparation. The basic concepts of high frequency confinement, with its technological difficulties, and a few experimental results are presented. (auth)

3812 CONTAINMENT OF PLASMAS IN RESONANT-CAVITY FIELDS. Hatch, Albert J.; Hasan, M. (Argonne National Lab., Ill.). pp 962-6 of Proceedings of the National Electronics Conference. Vol. XXII. Chicago, National Electronics Conference, Inc., 1966.

The depths and volumes of the Φ potential well for low-density plasmas and the T potential well for high-density plasmas were computed for the TM_{011} and the TE_{012} modes, respectively, of a cylindrical cavity. In a design study for an experiment being prepared at Argonne, the values Φ_{well} = 82 eV for the TM_{011} mode and T_{well} = 70 eV for the TE_{012} mode were obtained for an assumed input power of 2 kW (cw) at 900 MHz. (auth)

3813 TERMOYADERNYY REAKTOR BUDUSHCHEGO. (Thermonuclear Reactor of the Future). Kalinin, V. F. Moscow, Izd-vo Atomizdat, 1966. 203p.

Principles of thermonuclear reactions, methods of heating plasma, and methods of confining such plasma are described. Most of the operating experimental thermonuclear installations

throughout the world are described. The most promising type of thermonuclear reactor of the future is discussed. (JPRS)

3814 NEGATIVE "V" STELLARATOR. Lenard, A.; Kularud, R. M.; Johnson, J. L.; Bernstein, I. B. (to U. S. Atomic Energy Commission). U. S. Patent 3,278,384. Oct. 11, 1966.

The method and apparatus are described for magnetically confining a plasma column of ions and electrons away from the inside walls of a toroidal container by providing a negative "V" stellarator for achieving hydromagnetically stable confinement. In one embodiment the hydromagnetic instabilities known heretofore due to the finite resistivity of the plasma are overcome by a combination of crossed multipolar current carrying windings for providing a magnetic field tangent to a set of rested toroidal surfaces closing on a closed central line, the field also possessing a rotational transform, and superimposing thereon a multipolar field that produces a corrugation field that provides a ripple on the magnetic surfaces. Provision is also made for an embodiment of a negative "V" stellarator without a rotational transform. (AEC)

3815 PLASMA ACCELERATOR FOR USE IN A NUCLEAR FUSION REACTOR. Fonda-Bonardi, Giusto (to Litton Industries Inc.). German Patent 1,226,719. Oct. 13, 1966. Filed May 17, 1962.

A plasma accelerator, in which a plasma mass is accelerated along an evacuated closed path, has a rotating magnetic field for accelerating the plasma along the closed path, and means for confining the plasma to the closed path. A number of circularly arranged coils of U-shaped conductors are positioned sequentially around the exterior periphery of the said path and form an acute angle with the tangent to the path periphery. The coils are energized in sequence to generate the magnetic field rotating around the closed path, the field having a tangential force component for accelerating the plasma and also a centripetal component for confining the plasma to the closed path. (Gmelin Inst.)

Diagnostics of Plasma

Refer also to abstracts 3840, 3857, and 3883.

3816 (AD-642123) REFLECTION OF CIRCULARLY POLARIZED ELECTROMAGNETIC WAVES FROM AN ANISOTROPIC PLASMA. Scientific Report No. 4. RCA Victor Research Report No. 7-801-51. Bachynski, M. P.; Gibbs, B. W.; Graf, K. A. (RCA Victor Co., Ltd., Montreal (Quebec). Research Labs.). July 1966. Contract AF 19(628)-4071. 36p. (AFCRL-66-680). CFSTI $3.00 cy, $0.65 mn.

The reflection of both right-hand and left-hand circularly polarized plane electromagnetic waves, normally incident along the direction of an imposed static magnetic field in an anisotropic plasma, was investigated. Detailed measurements at a frequency of 9.2 Gc of the intensity and phase of the wave reflected from a helium afterglow plasma over wide ranges of plasma frequency and electron cyclotron frequency were carried out. The measured reflected power varied from less than one percent of the incident power to complete reflection and large undulations in both intensity and phase of the reflected wave with changing electron density and magnetic field were observed. Comparison with theory based on a simple sharply bounded uniform plasma slab shows good agreement for the general nature of the dependence of the reflected wave on the plasma properties. The exact electron densities corresponding to the maxima and minima and the absolute values of the intensity and phase of the reflected wave are not accurately predicted by this simple theoretical model. In the region of the electron cyclotron frequency, for an incident right-hand circularly polarized wave, the reflected signal undergoes a reduced variation in phase and the intensity, after attaining a maximum, is observed to decrease with increasing electron density. (auth)

3817 (ORNL-P-2613) CRYOGENICALLY COOLED, SCANNING ENERGY SPECTROMETER. Culver, J. S. (Oak Ridge National Lab., Tenn.). [1965]. Contract W-7405-eng-26. 13p. (CONF-661016-21). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Symposium on Engineering Problems of Controlled Thermonuclear Research, Gatlinburg, Tenn.

A new cryogenically cooled, scanning energy spectrometer was constructed for DCX-2. The solid-state preamplifier is built into the scanning head and operates in the same conditions of pressure and magnetic field as the plasma being studied. Cooling the silicon-barrier detector and preamplifier improved the resolution for 40-keV protons from 13 (F.W.H.M.) to 4.5 keV at 118°K. (auth)

3818 ELECTRIC CONDUCTIVITY OF A PARTIALLY IONIZED ARGON-POTASSIUM PLASMA IN A MAGNETIC FIELD. Feneberg, W. (Institut fuer Plasmaphysik, Munich). Z. Naturforsch., 21a: 1468-70(Sept. 1966).

In the case of small deviations from thermal equilibrium the second Enskog approximation is used as a starting point for solving the Boltzmann equation of the electrons in a partially ionized plasma. The distribution function is expanded according to Laguerre polynomials up to the order of 3. In this order the electric conductivity of a Lorentz gas, which is known exactly, is obtained to an accuracy of roughly 5%. The approximation tested in this way was then used to calculate the conductivity of an argon-potassium mixture at electron temperatures between 2000 and 3500°K. If only the collisions between electrons and argon atoms were to be considered, the electric conductivity in the absence of a magnetic field would, in view of the Ramsauer effect, be greater by a factor of 2.8 than that obtained with an infinitely strong magnetic field. When the interaction with the potassium atoms and the Coulomb interaction are taken into account as well the conductivity in the magnetic field varies by about 20%. (auth)

3819 MEASUREMENT OF HIGH ELECTRON DENSITIES WITH A NEW MICROWAVE REFLECTION PROBE IN A LINEAR Z PINCH. Hermansdorfer, H. (Institut fuer Plasmaphysik, Munich). Z. Naturforsch., 21a: 1471-8(Sept. 1966). (In German).

A microwave reflection probe method allowing the local measurement of electron densities well above the critical density is described. Measurements in the 35-Gc band on a Z pinch show its applicability. A rectangular waveguide with a dielectric aperture window serves as a probe. The interferometer for measuring the reflection coefficient is presented. It indicates phase angle and amplitude automatically without using modulators or frequency translators. Electron densities between 10^{13} cm^{-3} and 10^{16} cm^{-3} could be measured, facilitated by the transforming action of a dielectric $\lambda/4$ window. (auth)

3820 THERMAL PLASMA IN HIGH-TEMPERATURE CHEMISTRY. Riedel, Josef Tadeusz. Przegl. Elektron., 8: 407-11 (Aug. 1966). (In Polish).

The various types of plasmas of technological usefulness and some of their properties are reviewed. These properties include degree of ionization, steady state versus pulsed modes, open-arc plasmas, contained plasmas, and arc plasmas with solid electrodes and solution-type electrodes. The factors governing production costs and rate of production of such items as nitrates and HCN are mentioned. The chemical applications are generally hampered by an ignorance of high-temperature chemistry, as well as by difficulties in generating and containing plasmas and the reactive chemicals, and by power costs. Judging by the rate of growth of applications of plasmas, and by the amount of industrial and basic research being conducted with plasmas, large increases in the knowledge of high temperature plasma chemistry should soon be forthcoming. Conventional thermodynamics was utilized to calculate chemical equilibrium for HCN up to 6000°C. For higher temperatures, methods of statistical mechanics are used to calculate thermodynamic properties, and spectroscopic methods are used to determine reaction rates and chemical equilibrium. (TTT)

3821 OBSERVATION OF COOPERATIVE EFFECTS AND DETERMINATION OF THE ELECTRON AND ION TEMPERATURES IN A PLASMA FROM THE SCATTERING OF A RUBY LASER BEAM. Ramsden, S. A.; Benesch, R.; Davies, W. E. R.; John, P. K. (National Research Council, Ottawa). IEEE (Inst. Elec. Electron. Eng.) J. Quantum Electron., QE-2: 267-70(Aug. 1966).

The ruby laser was used to carry out experiments on the incoherent scattering of a beam of light from the free electrons in a plasma. Such experiments are likely to offer a powerful diagnostic tool for the determination of plasma parameters. From the relative intensity and spectral distribution of the scattered radiation it is possible to determine not only the electron density but also the velocity distribution of both the ions and electrons over a wide range of plasma conditions. Observations made on the forward scattering of a Q-spoiled ruby laser beam from a hydrogen plasma showed clearly both the central ion peak and the satellites due to cooperative interaction between the ions and electrons. In a separate experiment on a large Θ pinch producing a high-temperature deuterium plasma, the ion peak was resolved and values obtained for both the electron and ion temperatures in the plasma. Preliminary values of the ion temperatures are consistent with a thermonuclear origin for the neutron emission observed. (BBB)

3822 INTERACTION OF A PLASMA WITH A TRANSVERSE MAGNETIC FIELD. Zykov, V. G.; Sinitsa, N. G.; Stepanenko, I. A.; Tolok, V. T. pp 27-36 of Issledovanie Plazmennykh Sgustkov. Sinelnikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

A plasma produced by a conical source and injected into a cylindrical vacuum chamber in a diametral direction is discussed. The

magnetic field in the chamber was produced with the aid of coils, and could reach a maximum of 0.5 Tesla. The plasma diagnostics was with the aid of a magnetic probe and with the aid of a monochromator and a spectra[1] analysis of the hydrogen and carbon lines (4861 and 4267Å, respectively). The plasma motion was investigated only in the homogeneous section of the magnetic field. The measurements showed a noticeable change in the vacuum magnetic field resulting from the motion of the plasma generated in the chamber. The vacuum magnetic field was reduced inside the jet (crowded out) and increased on the sides of the jet. These changes were found to be due to the short circuiting of the polarized plasma by the conducting wall of the chamber. The crowded-out magnetic field increased with increasing plasma velocity and density. Various experiments have shown that the magnitude of the crowded-out magnetic field can vary widely with the plasma parameters (density, velocity, temperature). Plots are presented of the crowded-out magnetic field, the average plasma velocity, the electric polarization field, and the transverse plasma velocity against the magnetic field. The crowded-out magnetic field exhibits a maximum, but the average velocity and the transverse velocity decrease monotonically while the electric polarization field increases monotonically with increasing magnetic field. The plasma velocity depends also on the distance covered, decreasing monotonically with increasing distance. The decrease in plasma velocity in a direction perpendicular to the homogeneous magnetic field demonstrates the decrease in the polarization, and the decrease of the external magnetic field in the plasma jets indicates the presence of many factors which can affect the motion of the plasma through the transverse magnetic field. (ATD)

3823 BEHAVIOR OF PLASMOIDS IN THE LONGITUDINAL MAGNETIC FIELD. Krupnik, L. I.; Shulika, N. G.; Demchenko, P. A. pp 84-9 of Issledovanie Plazmennykh Sgustkov. Sinelnikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

Attempts were made to investigate the entrance of a plasmoid into an axially symmetrical magnetic field by sounding the plasma with beams. The sounding was carried out with beams of fast particles, using a procedure described earlier. The experimental setup was also described in detail in the earlier paper. The plasmoid was produced with a conical source with pulsed injection of gas. The magnetic field could be made homogeneous or inhomogeneous by using two or one solenoids. Measurement of the distance between the movable solenoid producing the magnetic field and the point of fast-particle sounding made it possible to determine the influence of the magnetic field on the plasmoid properties. The results show that in a field up to 2500 Oe a plasmoid with charged-particle density 10^{14} cm^{-3}, bounded by a diaphragm 15 mm in dia., follows strictly the magnetic force lines, and passes unchanged through the magnetic field gradient. No reflection of the plasmoid from the magnetic mirror or change in the density of the plasmoid were observed under these conditions. (ATD)

3824 MOTION OF THE FAST PLASMOIDS IN A MAGNETIC FIELD OF TOROIDAL SOLENOID. Voitsenya, V. S.; Gorbanyuk, A. G.; Onishchenko, I. N.; Safronov, B. G.; Shkoda, V. V. pp 119-29 of Issledovanie Plazmennykh Sgustkov. Sinelnikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

The behavior of a plasmoid moving with several-keV energy was studied in order to determine its upper density limit, its purity, and attainable velocity in longitudinal magnetic fields. The experimental apparatus is described showing a curved region preceded by a straight section connecting with the plasma injector. The plasmoid properties were studied with a mass spectograph, time-of-flight mass analyzer, microwave interferometer, and electric and thermocouple probes. In the experiments with low density plasma, the ion distribution was found to be considerably distorted. At 10^{12} cm^{-3} density, long high-energy tails appear. In higher density experiments, the mean ion energy was found to be 3 to 5 keV, with an impurity content of 40%. A study of the solenoidal guiding field indicates that plasma densities higher than 10^{13} ions/cm^3 are possible if fields are increased above the 8 kOe fields that were available. (ATD)

3825 DETERMINATION OF DENSITY, DEGREE OF IONIZATION, AND ELECTRON TEMPERATURE OF PLASMOIDS BY THE METHOD OF FAST PARTICLE BEAMS. Krupnik, L. I.; Shulika, N. G.; Demchenko, P. A. pp 188-95 of Issledovanie Plazmennykh Sgustkov. Sinelnikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

The parameters of plasma injected from a conical gun were investigated using neutral hydrogen and proton beams of various energies. This type of probing makes it possible to determine electron density, temperature and the degree of ionization as functions of time. Electron temperature measurements were supplemented by a spectroscopic method. These measurements helped to establish a gun operation regime producing impurity-free plasma with good repeatability from shot to shot. The absorption of the heavy particle beam was found to be quite useful since the plasma dynamics could be followed with approximately 30% accuracy without any significant interaction with the plasma. The measurements show that the plasma ejected from the gun has a forward part consisting of pure hydrogen with about 90% ionization. Its electron temperature reached some 60 to 80 eV. The tail part of the plasma carried large amounts of impurities (70%) and its temperature was quite low. The density of the forward part was about 10^{13} cm^{-3} and that of the tail part about ten times higher. Typical time variation of these quantities is shown. (ATD)

3826 IMPINGEMENT OF PLASMOIDS ON A METALLIC SURFACE. Krupnik, L. I.; Shulika, N. G.; Demchenko, P. A. pp 195-203 of Issledovanie Plazmennykh Sgustkov. Sinelnikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

Various aspects of the problem of colliding plasmas with metallic walls were studied using a conical plasma generator injecting plasma into a channel where diagnostic measurements on plasma properties were made. At the end of the channel, a reflecting metallic surface was set at 45°. The reflected plasma diagnostics were made in the vessel behind the reflector set at 90° to the incident plasma channel. The main tools for plasma analysis was the mass spectrograph and neutral atom beam. It was shown that in the region 1 to 2 cm from the reflector the plasma density increased by about a factor of 10. It is not clear what mechanism is responsible for such density increase. The mean energy of the particles in the investigated plasma changes by an insignificant amount with some addition of impurities from the reflecting surface. This is in contrast to earlier work where large peaks were found in the energy spectrum of reflected particles. The impurity composition was determined for several voltage regimes in the plasma generator giving the most efficient operation of the reflector. The coefficient of reflection was not studied in detail; its value (ratio of reflected number of particles to that of incident) is about 1:10. Orig. art. has: 5 figures. (auth)

3827 NEAR FIELD OF AN ANTENNA IN A MAGNETOACTIVE PLASMA. Franchi, P.; Orefice, A. (Univ., Milan, CNR, Milan). Nuovo Cimento (10), 44B: 95-106(July 11, 1966).

The near electric field of a small antenna in a magnetoactive plasma is studied by employing a quasi-static approximation. The field component along a receiving antenna is then evaluated in some typical cases. The explicit dependence of the electric field on the emitted frequency is finally given, as a simple example, with an elementary expression of the dielectric tensor. (auth)

3828 THE USE OF THE FIRST AND SECOND HARMONIC OF RUBY LASER LIGHT IN THE STUDY OF A FAST THETA PINCH. Martellucci, S.; Mazzucato, E. (EURATOM-CNEN, Frascati, Italy). Nuovo Cimento (10), 44B: 107-18(July 11, 1966).

By using as light source the first and second harmonic of a 20-MW ruby laser the schlieren technique was applied to the study of the implosion of a fast not preionized theta-pinch. It was found that the gradients of neutral atoms have a refractive effect lower than that of electrons and, at any rate, below the sensitivity limit of the schlieren mounting used. (auth)

3829 THERMAL IONIZATION OF A SUBSTANCE HAVING A METASTABLE LEVEL. Pozwolski, A. (Univ., Paris). J. Phys. (Paris), 27: 427-8(July-Aug. 1966). (In French).

The electron density of a thermal plasma may be considerably enhanced if metastable atoms are present. The Saha equation was generalized considering a gas composed of two classes of atoms which differ only by their zero level accordingly the model suggested by Brewer and McGregor. Ionization is computed by the method of Lagrange multipliers applying Maxwell–Boltzmann statistics to the gaseous mixture considered. (auth)

3830 TEMPERATURE DEPENDENCE OF SPECTRAL LINES INTENSITY EMITTED BY THERMAL PLASMA. Bielski, A. (Nicholas Copernicus Univ., Torun, Poland). Acta Phys. Pol., 30: 375-9(Sept. 1966).

Expressions are presented which make it possible to find the temperature dependence of atom, ion, and electron concentrations, and a graphical method is included for determining the temperature T_m at which the intensity of a spectral line reaches maximum value under the condition when the sum of atom and ion concentrations is constant (independent of temperature). This method can be applied to the lines emitted by atoms and ions of any multiplicity of ionization. (auth)

3831 SPATIALLY RESOLVED LASER HETERODYNE MEASUREMENTS OF PLASMA DENSITIES IN WEAKLY IONIZED GASES. Verdeyen, J. T.; Cherrington, B. E.; Fein, M. E.

(Univ. of Illinois, Urbana). Appl. Phys. Lett., 9: 360-2(Nov. 15, 1966).

A two-wavelength He:Ne laser heterodyne system was successfully used to measure electron number densities in the range from 4×10^{12} cm^{-3} to 10^{11} cm^{-3}, over a path length of 24 cm. These experiments were performed on a single-shot basis in pulsed argon discharges. The spatially resolved laser measurements compared quite favorably with integrated electron density measurements made with a microwave cavity operating in the TM_{010} mode. (auth)

3832 SELF-FOCUSING OF A LASER BEAM IN PLASMA. Rashad, A. R. M. (Memphis State Univ.). pp 19-24 of Proceedings of the National Electronics Conference. Vol. XXII. Chicago, National Electronics Conference, Inc., 1966.

The conditions under which a laser beam can be propagated through a plasma, without spreading by diffraction, i.e., self-focused, are analyzed in detail. The resulting nonlinear wave equation is solved for the case of a slab-shaped beam and for the case of a cylindrical beam configuration. The plasma absorption mechanisms of the laser energy are evaluated and also discussed. (auth)

3833 HEATING AND DISINTEGRATION OF A PLASMA PRODUCED BY A GIGANTIC LASER PULSE FOCUSED ON A SOLID TARGET. Basov, N. G.; Boiko, V. A.; Dementev, V. A.; Krokhin, O. N.; Sklizkov, G. V. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teoret. Fiz., 51: 989-1000(Oct. 1966). (In Russian).

The formation and properties of a plasma ("flare") produced by a gigantic laser radiation pulse focused on the surface of a solid target are investigated. Space–time diagrams of outward motion of the boundary and inner parts of the flare are obtained. The concentration distribution of particles in the flare are estimated and the plasma temperature and mass as a function of laser radiation power is measured. (auth)

3834 PERTURBATION OF ELECTRON ENERGY DISTRIBUTION BY A PROBE. Waymouth, John F. (Sylvania Electric Products Inc., Danvers, Mass.). J. Appl. Phys., 37: 4492-7 (Nov. 1966).

In order to determine electron-energy distribution in a plasma, the electron current to a probe is measured as a function of potential on the probe. If the rate of removal of high-energy electrons by measurement is comparable with the rate of replenishment by the various plasma processes, serious perturbation of the electron-energy distribution will result as a consequence of the act of measurement. A criterion for deciding when this effect may be ignored is presented. It is based on the hypothesis that when the depletion time constant τ_d of electrons of a particular energy by a given probe in a given plasma is large compared with the time for electrons to fill out a Maxwellian tail by Coulomb collisions as given by Montgomery and Tidman, perturbation of the electron-energy distribution is negligible. The depletion time constant is $\tau_d = 2.9V(mv^2/2kT_e)/A_pv)$, where V is plasma volume, A_p is the probe area, v is electron velocity, and T_e is electron temperature. The criterion for no perturbation of the electron-energy distribution then becomes $N \gg 1.5 \times 10^4 T^2 A_p$, in which N is the total number of electrons in the plasma, T is the temperature in degrees Kelvin, and A_p is the probe area in square centimeters. It is shown that even if the criterion is not satisfied, probe measurements of the electron-energy distribution may still be made by using a pulsed or transient system with pulses of length τ_p, provided $1/\omega_p \ll \tau_p \ll \tau_d$, where ω_p is the electron plasma frequency. (auth)

Kinetics of Plasma

Refer also to abstract 3824.

3835 (AD-641639) ENERGY TRANSFER FROM A TEST ELECTRON TO A COLLISIONLESS PLASMA. Kelley, Joseph G.; Levine, Morton A. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.). Sept. 1966. 40p. (AFCRL-66-630). CFSTI $3.00 cy, $0.65 mn.

The perturbation of a collisionless plasma by a nonrelativistic test electron is derived in closed form. The electron loses energy driving currents in the plasma. No energy is lost to electromagnetic or electro-acoustic waves. However, electro-acoustic waves do occur in the Mach cone behind the test electron and provide a mechanism to couple test electrons over large distances. (auth)

3836 (N-66-28485) EVOLUTION OF A PLASMA PUFF IN A LONGITUDINAL MAGNETIC FIELD. Moss, Samuel J. (Johns Hopkins Univ., Silver Spring, Md. Applied Physics Lab.). Jan. 1966. Contract NOw-62-0604-c. 74p. (NASA-CR-75683; TG-806). CFSTI $3.00 cy, $0.65 mn.

A hydromagnetic model of the evolution of a plasma puff in a B_z field was used to analyze the characteristics of the plasma produced by the conical pinch gun. The analysis is based on fitting the signals induced in single turn magnetic pickup loops by the passing plasma. In the cases studied good fits to the signals were achieved and the characteristic parameters of the plasma found. This analysis applied to plasma generated by the theta-pinch gun was not successful. In the two cases studied, the lack of good fits is attributed to the presence of a sizable amount of trapped field in the puff which is present along the entire flight path through the B_z field. (auth)

3837 (N-66-28518) COLLISION FREQUENCIES AND ENERGY TRANSFER IONS. Scientific Report No. 272. Banks, Peter M. (Pennsylvania State Univ., University Park. Ionosphere Research Lab.). May 15, 1966. 43p. (NASA-CR-75640). CFSTI $3.00 cy, $0.65 mn.

Ion collision frequencies and energy transfer for conditions of gaseous thermal nonequilibrium were investigated. The problems of ion–neutral and ion–ion elastic collisions were considered under the assumption of separate Maxwellian velocity distributions. Expressions for the nonequilibrium momentum transfer cross sections, collision frequencies, and energy transfer rates are given for neutral gases on the basis of a polarization potential and for ions on the basis of the Coulomb interaction. Next, the problem of ion–neutral resonance charge exchange is introduced in its effect upon collision cross sections and ion energy transfer rates. An analysis is made of gathered laboratory data to arrive at suitable expressions for the resonance charge exchange and momentum transfer cross sections for H^+, O^+, He^+, N_2^+, and O_2^+. Using these results, resonance charge exchange and momentum transfer collision frequencies are derived. The resonance ion–neutral energy transfer rates are then compared with expressions used in previous studies of ion temperatures. (auth)

3838 (N-66-29214) EXPERIMENTAL AND THEORETICAL PERFORMANCE OF COAXIAL PLASMA GUNS. Michels, Charles J.; Johansen, Albert E. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). July 1966. 34p. (NASA-TN-D-3469). CFSTI $3.00 cy, $0.65 mn.

Experimentally determined calorimetric exhaust efficiencies and exhaust velocities are compared with predicted values from a snowplow model analysis. Four gun geometries (employing argon propellant) are examined analytically and experimentally over a range of initial masses and voltages. Noncrowbarred and crowbarred results are described. Experimentally stable operation of a gun was limited to mass distributions for which a simplified analysis limits maximum efficiencies to about 40%. Experimentally measured efficiencies for optimum propellant distributions are approximately one-half those predicted from the simplified analysis (the maximum experimental efficiency was 22.2%). Experimental efficiencies agree somewhat better with peak efficiencies predicted by the complete theory. Experimental velocities agree approximately with both forms of the theory, but are generally somewhat lower. (auth)

3839 (N-66-29435) COMPUTER EXPERIMENTS IN PLASMA PHYSICS. Buneman, O.; Dunn, D. A. (Stanford Univ., Calif. Inst. for Plasma Research). Jan. 1965. 61p. (NASA-CR-57710; SU-0254-2). CFSTI $3.00 cy, $0.65 mn.

The equations of motion of many interacting particles can be solved simultaneously using modern computers. Given the initial conditions, the subsequent behavior of all of the particles can be calculated and examined in graphs and motion pictures. The results of such computer experiments have led to new insights in many areas of plasma physics. (auth)

3840 (NP-16380) MICROWAVE DRIVEN MAGNETIC PLASMA ACCELERATOR STUDIES (CYCLOPS). Semiannual Report. Eckert, A. C.; Crimi, G. F. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). Sept. 28, 1966. Contract NAS 3-8903. 99p.

A microwave-driven magnetic plasma accelerator was investigated. The thrust produced by this accelerator was measured for three different propellants and for limited ranges of the parameters, propellant input flow rate, input power, and magnetic field strength. Overall efficiencies between 0.09 and 0.33 were obtained using krypton at specific impulse values between 2000 and 3000 seconds. Thrust efficiencies for argon and xenon were generally lower than for krypton. By use of a retarding potential probe, ion energies were directly determined and compared to values deduced from simultaneous thrust measurements. The occurrence of differences between thrust-determined and retarding-potential probe-determined values suggests that entrainment was occurring for background pressures in the high 10^{-5} torr range. Further measurements of plasma potential using emitting Langmuir probes provided further evidence for entrainment. Entrainment effects appeared to increase significantly as the electron cyclotron reso-

nance point was moved out from the engine into the test chamber volume by increasing the magnetic field. Designs are discussed for conversion to mercury operation. It is expected that this will eliminate entrainment by reducing the background pressure. The design of a facility for operating the microwave plasma accelerator in the pulsed mode, where both the gas flow and the rf power are pulsed, is presented. Preliminary results of rf field mapping and cold gas flow in this system are reported. (auth)

3841 (AD-639428) MEASURING THE AVERAGE ELECTRON ENERGY LOSSES DURING THE DIFFUSION OF THE ELECTRON BEAM IN PLASMA. Pasichnyk, L. L. Translated from Ukr. Fiz. Zh., 9: 1027-30(1964). 9p. (FTD-TT-65-1920). CFSTI $3.00 cy, $0.65 mn.

A method is described for measuring the electron energy losses in the plasma at anomalous diffusion. The results show that the electrons lose up to 20% of their initial energy. (M.O.W.)

3842 RADIAL PARTICLE PROFILE IN NEGATIVE GLOW NEON PLASMA. Chiplonkar, V. T.; Desai, Y. R. (Inst. of Science, Bombay). Curr. Sci. (India), 35: 582-3(Dec. 5, 1966).

The radial density profile was observed in neon ($p = 260\mu$; $i_{dc} = 4.5$ mA; $V_{dc} = 1160$ V) by the double-probe method, when both the probes were in the negative glow plasma. The plasma was generated in a cylindrical discharge tube of 1.3-cm radius. The exploring probe was moved radially from the geometrical position of the wall to the axis of the tube by a micrometer screw movement. (W.D.M.)

3843 EFFECT OF COULOMB COLLISIONS ON CONTRASTREAMING PLASMAS. Buti, B. (National Physical Lab., New Delhi. Goddard Space Flight Center, Greenbelt, Md.); Trehan, S. K. Ann. Phys. (N. Y.), 40: 296-320(Nov. 1966).

The instability of contrastreaming plasmas is investigated taking into account the Coulomb collisions via the Fokker–Planck coefficients in the Boltzmann equation. The dispersion relation is obtained on the assumption that the Coulomb collisions are weak and solved on the additional assumption that the phase velocity of the wave is much larger than the mean thermal velocity of the particles. It is found that while the temperature has the effect of increasing the maximum wavenumber x_c(which for a cold plasma is equal to $(2)^{1/2}$ in units of ω_p/U, where ω_p is the electron plasma frequency and U is the streaming velocity) below which the plasma is unstable, the collisions have no effect on this wavenumber. However, the growth rate of maximum instability decreases (compared to its value for a cold plasma) on taking into account the thermal motions but increases when the collisions are taken into account. (auth)

3844 DISPERSION AND DAMPING OF OSCILLATIONS IN MAXWELLIAN PLASMAS WITH NONUNIFORM ZERO-ORDER DENSITIES. Lee, Kai Fong (Cornell Univ., Ithaca, N. Y.). J. Appl. Phys., 37: 4367-72(Nov. 1966).

The dispersion and damping of oscillations in Maxwellian plasmas with zero-order density gradients are studied using the Vlasov and Maxwell's equations. The plasmas are confined by a strong axial magnetic field and the densities are nonuniform in the transverse directions. By means of a variational method, it was found that the oscillation characteristics are governed by a parameter γ, which depends on the ratio of wavelength to the scale of inhomogeneity. Physically, γ is a measure of the weighted average density, with the square of the electric field as the weighting factor. It is always greater than or equal to unity; unity is the limiting case of an infinite and homogeneous medium. As γ increases, the effective plasma density is decreased and the following changes occur: (1) The real frequency of oscillation and the phase velocity are reduced. (2) The group velocity is increased. (3) Landau damping is increased. These changes are evaluated quantitatively for Gaussian and exponential density profiles. (auth)

3845 ELECTRON RECOMBINATION IN LASER-PRODUCED HYDROGEN PLASMA. Litvak, M. M.; Edwards, David F. (Massachusetts Inst. of Tech., Lexington). J. Appl. Phys., 37: 4462-74(Nov. 1966).

Time-resolved spectroscopic measurements were made of the decay of a laser-produced discharge in hydrogen over a range of pressures from 1 to 70 atm. Stark widths and line-to-continuum intensity ratios yielded the electron density and temperature–time history, which indicated temperature decay because of radiation and expansion cooling and electron loss because of collisional-radiative recombination, as verified by solutions obtained from the rate and energy equations. (auth)

3846 NONLINEAR MOTIONS OF A PLASMA WITH AN ARBITRARY ELECTRON VELOCITY DISTRIBUTION. Akhiezer, I. A.; Borovik, A. E. (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Zh. Eksp. Teoret. Fiz., 51: 1227-35 (Oct. 1966). (In Russian).

One-dimensional finite-amplitude motions in a nonequilibrium plasma consisting of hot electrons and cold ions are investigated. Stationary waves and also nonstationary multi-beam flows of the simplest type (Riemann or simple waves) are considered. It is shown that solitary waves may be of two types depending on the nature of the electron velocity distribution. The particle density and electrostatic potential increase in solitary compression waves whereas in rarefaction waves these quantities decrease. When the electron distributions are such that solitary rarefaction waves are produced, reflection of electrons from the potential barrier produced by the wave may result in the formation of quasi-shock rarefaction waves (in contrast to quasi-shock compression waves arising in a plasma with a Maxwellian electron distribution). The sign of variation of the quantities characterizing the plasma in a multi-beam simple wave is established. It is shown that depending on the nature of the initial electron velocity distribution, either the normal case may be encountered, when discontinuities (or additional ion beams) arise on the compression regions, or the anomalous case, when the discontinuities arise in the rarefaction regions. (auth)

3847 EQUATIONS FOR WAVE PROPAGATION IN A STRATIFIED COMPRESSIBLE ELECTRON–ION MAGNETO-PLASMA. Burman, R. (Victoria Univ., Wellington, New Zealand). Electron. Lett., 2: 415-16(Nov. 1966).

The propagation of coupled electromagnetic, electron-acoustic and ion-acoustic waves in a horizontally stratified horizontally magnetized compressible electron–ion plasma is described. Propagation transverse to the magnetostatic field is considered, and some first-order coupled-wave equations are derived. (auth)

3848 GROWING-WAVE PHENOMENON DUE TO COLLISION COUPLING IN A WARM COMPRESSIBLE DISSIPATIVE ELECTRON PLASMA IN UNIFORM MOTION. Knop, C. M. (Andrew Corp., Chicago). Electron. Lett., 2: 422-3(Nov. 1966).

A single solution was found for a conventional linear model of an electron plasma (with a specific set of plasma conditions satisfied) which predicts a growing space-charge wave due to collision coupling, but that this solution does not represent energy conversion. (auth)

3849 EXTENSION OF THE PLASMA KINETIC EQUATION TO SMALL WAVE NUMBERS. Kaufman, Allan N. (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev. Lett., 17: 1127-9(Nov. 28, 1966). (UCRL-17207).

The equation for the evolution of the electron velocity distribution, in a stable uniform electron–ion plasma, is extended to wave numbers so small that collisional damping exceeds Landau damping for electron plasma waves. (auth)

3850 COLLISIONAL MECHANISM FOR PRODUCING ELECTRON CYCLOTRON ECHOES FROM PLASMAS. Crawford, F. W.; Harp, R. S. (Stanford Univ., Calif.). J. Appl. Phys., 37: 4405-16(Nov. 1966).

Recent experimental work has established that repeated pulsing, at the electron cyclotron frequency, of a plasma in a slightly inhomogeneous magnetic field results in the stimulation of echo trains. It has been recognized that the production mechanism for these echoes involves some nonlinear process, but those suggested and analyzed previously have not given results agreeing satisfactorily with experiment. In this paper, it is shown that if electron–neutral momentum transfer collisions are taken into account, a suitable nonlinear theory predicting both two-pulse and three-pulse echo characteristics can be developed. Computations based on this theory are presented, and agree well with the published experimental observations. (auth)

3851 NATURAL RESONANCE MODES OF CYLINDRICAL PLASMAS. Battocletti, Joseph H. (Badger Meter Mfg. Co., Brown Deer, Wis.). pp 66-71 of Proceedings of the National Electronics Conference. Vol. XXII. Chicago, National Electronics Conference, Inc., 1966.

When an electromagnetic wave of fixed frequency is incident on the cylindrical positive column of a low-pressure mercury-vapor discharge, a spectrum of resonances of reflection and transmission occurs as the discharge current of the positive column is varied. The resonances due to the natural modes of the plasma column are theoretically discussed. (M.O.W.)

3852 PLASMA OSCILLATIONS OF THE ELECTRON SHELL OF THE ATOM. Kirzhnits, D. A.; Lozovik, Yu. E. (Lebedev Inst. of Physics, Moscow). Usp. Fiz. Nauk, 89: 39-47(May 1966). (In Russian).

The theory of plasma (collective) oscillations of the atomic shell (atomic plasmon) and the part that it plays in various atomic reactions brought about by electron-atom or atom-ion collisions and by interactions between electromagnetic radiation and the atom are discussed. Recent data are reviewed on the spectrum of the oscil-

lations (natural frequency, damping, and multipole order), the characteristics describing the probability of excitation of the plasma oscillations (oscillator strengths), and the degree and character of participation of the plasmon in atomic reactions. Many still unanswered questions in connection with all these topics are pointed out and discussed. A microscopic description of plasma oscillations is formulated in terms of the dielectric constant of the atom. Particular attention is paid to a determination of the damping of the plasma oscillations and the ratio of the damping to the frequency. The relation between plasma oscillations and direct nuclear reactions as well as reactions proceeding via a compound nucleus is discussed. An examination of the available experimental data shows them to be insufficient for unambiguous conclusions, and further experiments are needed, especially on photoatomic reactions with heavy atoms at energies on the order of several keV. (ATD)

3853 RADIATION OF HARMONICS n ω_e AND $\frac{1}{2}$ n ω_e FROM A BEAM-GENERATED PLASMA. Landauer, G.; Mueller, G. (Institut fuer Plasmaphysik, GmbH, Garching, Ger.). Phys. Lett., 23: 555-7(Nov. 28, 1966).

The conditions under which harmonics of the electron gyrofrequency are emitted from an electron beam plasma are investigated experimentally. (auth)

3854 RESONANCE RADIATION OF ELECTRONS OF ENERGY UP TO 600 MeV IN A LAYERED MEDIUM. Arutyunyan, F. R.; Ispiryan, K. A.; Oganesyan, A. G.; Frangyan, A. A. (Joint Radiation Lab., Academy of Sciences, Armenian SSR. Erevan State Univ.). JETP Lett. (USSR) (Engl. Transl.), 4: 187-90(Oct. 15, 1966).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 4: 277-82(Oct. 15, 1966).

Experimental results are presented on the characteristics of the radiation produced in different layered media by passage of high-energy electrons. The number of electrons in a pulse stretched out to 0.5 sec was ~10^2 to 10^4, depending on the electron energy, which was varied between 250 and 600 MeV with $\Delta E/E \lesssim 5\%$. Several radiation spectra are described. (M.O.W.)

3855 RAPIDLY RECOMBINING PLASMA JETS. Gudzenko, L. I.; Filippov, S. S.; Shelepin, L. A. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teoret. Fiz., 51: 1115-19(Oct. 1966). (In Russian).

Rapid cooling of a magnetized plasma jet expanding into vacuum is considered. The estimations obtained indicate the possibility of producing in this way a medium with an essentially nonequilibrium level population. (auth)

3856 MAGNETOHYDRODYNAMIC WAVES. Polovin, R. V.; Cherkasova, K. P. (Physicotechnical Inst., Kharkov). Usp. Fiz. Nauk, 88: 593-617(Apr. 1966). (In Russian).

Research on magnetohydrodynamic waves in homogeneous media with special attention to stability of the MHD currents and its relation to the evolutionary conditions is discussed. Only qualitative results and simple formulas are presented, reference being made to the original sources for more complicated formulas and derivations. Detailed descriptions are presented of the seven possible MHD waves that can exist in a stationary homogeneous medium (two fast magnetosonic waves, two slow magnetosonic waves, two Alfvén waves, entropy wave) together with their appropriate group and phase polars and their characteristic equations; the possible flows that can exist in such a medium (slow, pre-Alfvén, super-Alfvén, and fast); the changes of the longitudinal and transverse velocities, density, pressure, and magnetic field in the different waves; the effects of ionization, detonation, combustion, shock, and rarefaction waves; and splitting of various waves and possible combustion and detonation modes. (ATD)

3857 EXPERIMENTAL STUDY OF THE m = 1 AND m = −1 MODES OF PROPAGATION OF AN ELECTROMAGNETIC WAVE ALONG A PLASMA COLUMN UNDER A LONGITUDINAL MAGNETIC FIELD. Leprince, Philippe; Maurin, Christian; Pommier, Jacqueline (Laboratoire de Physique des Plasmas, Orsay, France). Compt. Rend., Ser. B, 263: 757-60(Sept. 26, 1966). (In French).

The experimental dispersion curves were traced for the two dipolar modes. The resonances over each of these modes were studied and the parts played by the wavelength and the frequency in the propagation of the wave were clarified. The limits of the validity of the quasi-static approximation were also shown. (tr-auth)

3858 QUASILINEAR THEORY OF CHERENKOV AND CYCLOTRON ATTENUATION OF ELECTROMAGNETIC WAVES IN A PLASMA. Sizonenko, V. L.; Stepanov, K. N. (Inst. of Physics and Tech., Kiev). Zh. Eksp. Teor. Fiz., 51: 858-67 (Sept. 1966). (In Russian).

Cherenkov absorption of Alfven and fast magnetoacoustic waves in a plasma with a high gas-kinetic pressure ($4\pi n_0 T/H_0^2 \gtrsim 1$) is investigated in the quasilinear approximation. Cyclotron absorption of fast magnetoacoustic waves by ions and of ordinary and extraordinary waves by electrons in a plasma with a low gas-kinetic pressure ($4\pi n_0 T/H_0^2 \ll 1$) (where n_0 and T are respectively the plasma density and temperature and H_0 is the external magnetic field strength) are investigated in the same approximation. It is shown that the various components of the field amplitude of Alfven waves and also of fast magnetoacoustic waves propagating almost parallel to the external magnetic field possess different decrements. The decrement difference is of the order of the inverse ion diffusion time on waves in velocity space. It is also shown that the appearance of a "plateau" in the ion distribution function may lead to a strong increase (as compared to the linear theory) of Cherenkov absorption of Alfven waves. (In a plasma with a low gas-kinetic pressure appearance of a "plateau" would always result in a decrease of the decrement.) The cyclotron decrements of a fast magnetoacoustic wave and of the ordinary and extraordinary waves may also increase with increase of the field amplitude due to the "plateau" formation. (auth)

3859 SINGULAR SOLUTIONS OF THE EQUATIONS FOR PLASMA OSCILLATIONS. Karpman, V. I. (Novosibirsk State Univ., USSR). Zh. Eksp. Teor. Fiz., 51: 907-14(Sept. 1966). (In Russian).

The effect of Coulomb collisions on plasma oscillations with frequencies and decrements which depend on the initial perturbation (singular solutions) is considered. In total absence of collisions such oscillations may decay at a slower rate than oscillations with a Landau decrement. It is shown that Coulomb oscillations of a very low frequency (much smaller than the Landau decrement) result in a very rapid decay of the peculiar solutions. (auth)

3860 QUASILINEAR THEORY OF ION-ACOUSTIC WAVES. Kovrizhnykh, L. M. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 51: 915-20(Sept. 1966). (In Russian).

A one-dimensional theory of ion–acoustic waves in a plasma is developed in the quasilinear approximation by taking into acount collisions. An explicit expression for the spectral density of ion–acoustic waves as a function of time is found for a current plasma which is unstable in the linear approximation and is located in an external electric field. It is shown that in the stationary state the wave intensity depends on the magnitude of collision attenuation and on Landau attenuation on ions. The propagation of intense ion–acoustic waves in a plasma is also considered and it is shown that the nature of their attenuation also depends in an essential manner on the collision frequency. (auth)

3861 RAPID RECORDING OF THE LUMINOSITY FROM A DECAYING PLASMA. Waidmann, G.; Hopmann, W. (Kernforschungsanlage, Juelich, Ger.). Z. Angew. Phys., 21: 480-1 (1966). (In German).

The time dependence of the electron density in decaying plasmas may be used to determine diffusion and recombination coefficients. A detailed knowledge of the electron density profile is necessary. Knowing the relation between the radiation of the afterglow plasma and the electron density the density profile can be evaluated from the luminosity profile. A photoelectronic method for fast registration of temporally changing luminosity profiles is described. An Image-Orthicon camera tube is used as a high speed shutter. Luminosity profiles of a decaying hydrogen plasma are shown as an example. (auth)

3862 NONLINEAR EFFECTS IN A HOMOGENEOUS LORENTZ PLASMA UNDER AN hf ELECTRIC FIELD. Jancel, Raymond (Institut Henri Poincare, Paris). Compt. Rend., Ser. B, 263: 601-4(Aug. 29, 1966). (In French).

The anisotropies and the harmonics of a homogeneous Lorentz plasma under an hf electric field were calculated by an approximation method proposed previously. It is shown that in the case of an interaction in $1/r^5$, there is no generation of harmonics in the electronic current. (tr-auth)

3863 DISSOCIATION ION CURRENT MAXIMA BY THE LATERAL EXTRACTION OF NEGATIVE IONS FROM A LAYERED OXYGEN PLASMA. Drost, H.; Klotz, H.-D.; Timm, U.; Pupke, H. (Institut fuer Biophysik, Berlin). Exp. Tech. Phys., 14: 135-9(1966). (In German).

The intensity variation traced by the lateral extraction of negative ions along the striated column of an oxygen discharge shows a significant maximum dissociation in the case of broad layers. The effect appears to be oxygen-specific, since in an argon discharge no structured ion current maximum could be observed from the Doppler-broadened layers. The maximum dissociation is explained by the existence of Doppler layers. (tr-auth)

3864 PROPAGATION OF SMALL-AMPLITUDE WAVES IN INCOMPLETELY IONIZED PLASMA. Wilhelm, Johannes;

Wisliceny, Johann (Univ., Greifswald, Ger.). Beitr. Plasmaphys., 6: 89-137(1966). (In German).

The principles of a free-continua theory with the propagation of waves in incompletely ionized plasma are reported. A summary and generalized review of the dispersion behavior of waves in plasma in which the neutral gas components cannot be neglected is presented. The initial equations are derived, transformed, and processed to dispersion equations for pressure/isotropy ratios. These are very complicated as they include five wave types. The study is therefore limited to the case in which the dispersion equations are very simplified. The dispersion behavior of waves in the absence of external magnetic fields and for propagations parallel and perpendicular to the external magnetic field was investigated. The effect of pressure and isotropy was then considered. (J.S.R.)

3865 MOTION OF AN IONIZED GAS IN ELECTRIC AND MAGNETIC FIELDS. Ishimura, Tsutomu; Yamanaka, Chiyoe (Osaka Univ.). Cho-koon Kenkyu (Osaka), 2: No. 3, 3-24(Sept. 1965). (In Japanese).

A lecture meeting was held on "motion of ionized gas in electric and magnetic fields" in February 1965 at the Institute of Space and Aeronautical Science (Univ. of Tokyo). These seven lectures given at the meeting are discussed: (1) cusp experiments at Univ. of Osaka—descriptions of the experimental study to clarify problems in the method of plasma containment in a plasma bottle by producing the plasma outside the bottle, then injecting it into the bottle; (2) plasma shock-wave; experiments and results, and ionization by shock waves; (3) plasma production of plasma by lasers, diagnosis of plasma with lasers, and a nonlinear phenomenon produced by lasers; (4) electronic computer experiments on plasma, plasma models, and a model representing ion-cyclotron waves; (5) experiments on MHD flow—description of the experimental results on and the future plan for, at the Univ. of Osaka, especially the interaction between the ionized gas flow and a magnetic field; (6) approximate fundamental equations expressing the flow of an ionized gas; (7) distribution function of plasma and effects of electric and magnetic fields—distribution function in the external electric field, and electron runaway. (NSA of Japan)

3866 INTEGRALS IN THE THEORY OF ELECTRON CORRELATIONS. Onsager, L.; Mittag, L.; Stephen, M. J. (Yale Univ., New Haven). Ann. Physik (7), 18: No. 1-2, 71-7(1966).

Two integrals occurring in the theory of a degenerate electron gas are evaluated exactly. These integrals represent the zero point plasma energy and second order exchange energy respectively. (auth)

3867 ISSLEDOVANIE PLAZMENNYKH SGUSTKOV. (Study of Plasma Clusters). Sinelnikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. 214p.

Separate abstracts were prepared for 22 of the 24 included papers. For abstracts of the remaining papers see 19: 21577 and 37994. (M.O.W.)

For abstracts of individual papers see: 3810, 3822–3826, 3868–3880, 3884, 3900, and 3901.

3868 TRANSVERSE INJECTION OF A PLASMA IN A MAGNETIC FIELD. Sinelnikov, K. D.; Rutkevich, B. N. pp 5-16 of Issledovanie Plazmennykh Sgustkov. Sinelnikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

Making use of the laws of conservation of the number of particles, of the energy, and of the momentum, calculations were made for the drift velocity, the components of the dielectric tensor, the field energy density, the plasma velocity, the flux density of the energy of orbital motion of the electrons and the ions, and other parameters of a plasma injected transversely into a magnetic field. Special attention is paid to the spreading of the plasma along the magnetic field, and it is shown that this effect is not due to collisions alone, but also to the effect of the electric fields which result from the distortion of the magnetic field at the point where the plasma is injected. (ATD)

3869 COLLAPSE OF A PLASMOID IN AN EXTERNAL GROWING MAGNETIC FIELD. Khizhnyak, N. A. pp 37-53 of Issledovanie Plazmennykh Sgustkov. Sinelnikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

The conditions for effective collapse of a plasmoid are discussed, under conditions when the energy of the ions on the axes of the collapsing plasmoid can be maximal, since the collapse of plasmoids has been recently considered as a possible source of obtaining colliding fast ions on the axis, thereby generating neutrons of thermonuclear origin. Conditions are considered under which the energy of the ions on the axis can be maximal, and also under which the energy of the external alternating magnetic field can be transformed predominantly into the energy of the ionic component of the plasma. The analysis is based on the equations for the interaction between a small plasmoid and external fields, which are a further generalization of the equations of the model of the flexible current loop used to describe the interaction between a plasmoid and stationary fields. These in turn are a generalization of the equations of magnetohydrodynamics to include small limited plasma formations. Equations for the self-inductance of the plasmoid, and the resistance of the plasmoid are derived and discussed, and conditions are given for ohmic and collisionless damping of the currents and the plasma, and for the frequency of the oscillations accompanying the collapse. Some of the results are compared with those obtained by others. (ATD)

3870 COEFFICIENTS OF MUTUAL INDUCTANCE OF COAXIAL SPHEROIDAL PLASMOIDS. Cherkasova, K. P.; Khizhnyak, N. A. pp 61-8 of Issledovanie Plazmennykh Sgustkov. Sinelnikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

The method of flexible current loop for the analysis of interaction between plasmoids and specified magnetic fields, developed earlier is extended to describe the interaction between extended plasmoids with external magnetic fields. The extended plasmoid is represented in the form of a chain of coaxial cylindrical plasmoids which interact with one another. The individual links of the chain are chosen sufficiently small to be able to neglect the variation of the external magnetic field. The problem consists essentially of writing out the equation for the electric equilibrium for each of the individual plasmoids and determining the coefficients of mutual inductance and their behavior as functions of the plasmoid dimensions and the distances between their centers, since these coefficients are contained in the equation for the electric equilibrium. It is assumed in the determination of the inductance coefficients that only electronic currents are excited in the plasmoid. The mutual inductance coefficient is first obtained for two spherical plasmoids, followed by calculation for oblate and prolate spheroids. The effects of certain approximations on the calculations are briefly discussed. (ATD)

3871 INTERACTION OF PLASMOIDS WITH AN AXIALLY SYMMETRIC MAGNETIC FIELD. II. Azovskii, Yu. S.; Guzhovskii, I. T.; Mazalov, Yu. P.; Pistryak, V. M. pp 68-76 of Issledovanie Plazmennykh Sgustkov. Sinelnikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

An investigation was made to determine the interaction of the plasmoid and the character of its motion in an inhomogeneous magnetic field, in the case of dense plasmoids for which the adiabatic conditions are not satisfied. The apparatus and the test procedure are described. The tests yielded plots of the dependence of the density and radius of the plasmoid on the position of the plasmoid in the magnetic field, the dependence of the position of the plasmoid on the time, and the radial distribution of the particles in the plasmoid, the dependence of the vacuum magnetic field. the induced-current field, and their ratio on the vacuum magnetic field at the center of the solenoid, and the dependence of the radius and density on the magnetic field. While most of the results can be reconciled with the qualitative theoretical descriptions of this phenomenon published by others, the plasmoid exhibited an unexpected acceleration in the region beyond the point corresponding to the maximum current. It is noted in conclusion that the results differ greatly from the earlier investigation, primarily because the plasma used there consisted essentially of heavy carbon and oxygen ions. The maximum compression rate in the magnetic field was produced where the magnetic field had a maximum gradient. The induced current first increased with the field, and then more rapidly than the field. However, once the plasmoid was radially compressed, the induced current began to decrease rapidly. A noticeable crowding out of the magnetic field was observed, causing the axial field in the plasma to drop to about 15% of the vacuum field. The induction of the current was accompanied by a certain slowing down of the plasmoid motion, thus indicating that the translational energy was converted partially into radial and rotational energy. (ATD)

3872 INTERACTION OF PLASMOIDS WITH AN AXIALLY SYMMETRIC MAGNETIC FIELD. III. Azovskii, Yu. S.; Akhmerov, R. V.; Guzhovskii, I. T.; Mazalov, Yu. P.; Pistryak, V. M. pp 76-84 of Issledovanie Plazmennykh Sgustkov. Sinelnikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

The plasma was produced by a conical source, propagated through a glass tube, and interacted with a magnetic field produced by coils located 50 cm from the source. The time-integrated radiation spectrum was photographed near the maximum magnetic field gradient and in the region of the homogeneous field. The plasma was either pure hydrogen or 75% hydrogen and 25% helium. The results show that the integral radiation, the continuous radiation, and the radiation of the helium and the impurities had the same character, whereas the glow due to the hydrogen was much

longer. The latter is due to the longer recombination time of the hydrogen. An increase in the magnetic field increased all the components of the radiation, after which the increase slowed down. Measurements were also made of the dependence of the radius, density, and electron temperature of the plasmoid as functions of the analytic field and the dependence of the position of the injected plasmoid and the reflected shock wave in the plasma as functions of the time. (ATD)

3873 TRAVERSAL OF A SPATIALLY NONUNIFORM MAGNETIC FIELD BY PLASMOIDS. Kalmykov, A. A.; Tereshin, V. I.; Chebotarev, V. V. pp 103-11 of Issledovanie Plazmennykh Sgustkov. Sinelnikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

Plasmoid motion in a nonuniform magnetic field is studied with particular emphasis on the blocking of the slow-moving tail part which carries a large amount of impurities and is not strongly ionized. Periodic space perturbation of magnetic field was introduced in such a way that the high conductivity pure part of the plasmoid was not greatly affected, while the cooler tail end interacted strongly with the field. These experiments were performed on straight sections of a plasma guide using magnetic probes, spectroscopy and a pulsed plasmascope for the study of plasmoid properties. Magnetic probes showed the almost complete expulsion of the magnetic field by the fast (5×10^6 cm/sec) portion of the plasmoid. These measurements were used to determine the extent of a high-conductivity plasmoid as its position in the guide changed. It was shown that as the amplitude of the nonuniform field increased, the upper limit on the ion velocity moved toward lower speeds. It was further shown that the greatest losses of the high conductivity part of the plasmoid was due to particles following force lines toward the vessel walls. The plasmoid component which propagates best in such fields was that for which the conditions of high frequency stabilization are met, provided the appropriate space-modulation oscillation replaces the stabilizing frequency. (ATD)

3874 INVESTIGATION OF PLASMOIDS MOVING IN A TOROIDAL MAGNETIC FIELD. Ilenko, B. P.; Latsko, E. M.; Zalkind, V. M.; Zykov, V. G.; Tolok, V. T. pp 129-36 of Issledovanie Plazmennykh Sgustkov. Sinelnikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

Electric fields arising due to polarization in plasma were studied for three cases: (1) in curved magnetic fields with varying radii of curvature, (2) in a toroidal field where two plasmoids collide, and (3) in a case where a plasmoid moves along the toroidal field. The measurements were performed with two probes, one near the vessel wall and the other located at a given point in the plasma. The plasma was generated in a conical pinch gun and injected into the working region. The experiments show that polarization fields consist of the components along the toroid's major and minor radii and along the toroidal axis. Initially, the latter two components dominate in the main part of the plasmoid; subsequently, only the axial component is dominant. Plasma density was also found to increase by an order of magnitude at the exit from the helical magnetic field of a curved toroidal section. Data for the various cases showing both space and time dependence of the various quantities measured are graphed. (ATD)

3875 PLASMA ACCELERATION IN CROSSED FIELDS. Khizhnyak, N. A. pp 137-48 of Issledovanie Plazmennykh Sgustkov. Sinelnikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

The requirements for neutral plasma acceleration in crossed electric and magnetic fields are discussed. The analysis is performed for rail gun accelerators. It is shown that when the plasma density of the accelerated plasmoid is high, the plasmoid should be considered as an ohmic load for typical circuit parameters employed in many experiments. If the density of plasma is low and the same circuit parameters are used, the load is capacitive. For the case of very low density or very low-inductance circuit, the inductive characteristics of the plasma load emerge. The first two cases are considered in detail and examples are provided. It is found that the conditions for ohmic loading of the gun by accelerating plasma are difficult to achieve. In the case of capacitive loading, 20 to 25% of the stored energy can be transferred to the plasma, with the optimum plasmoid velocity being (c/2) (E/H). Such loads are much more easy to achieve than ohmic loads. It is also noted that account must be taken of the current variation in various portions of the plasmoid, which in turn may induce plasma instabilities which complicate the simplified behavior of plasma acceleration described above. (ATD)

3876 CURRENT DISTRIBUTION IN A COAXIAL PLASMA GUN. Zolototrubov, I. M.; Kiselev, V. A.; Novikov, Yu. M. pp 148-56 of Issledovanie Plazmennykh Sgustkov. Sinelnikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

The current distribution in a coaxial plasma gun and the electrodynamic forces acting on the plasma were investigated. The current distribution was determined by a differential magnetic probe and the measurements were taken at different delays between the initial gas injection and time of the discharge. When this delay was 200 to 300 μsec, discharge current formed several sheets arising due to partial current flows at insulation walls. The probe and fast streak photography data showing this effect are given. Evidence of the trapped magnetic field between the current sheets was also found. It was found that for small delay times, only single current sheets are formed and that their velocity drastically increases during the current maximum. In addition to current sheets, observation of plasmoids was made and it was found that their velocities reached several times that of the sheets (8×10^7 cm/sec) showing that they are not accelerated by the electromagnetic interaction with the current, but rather by the drift-inducing fields. (ATD)

3877 OPERATION OF THE COAXIAL PLASMA SOURCE IN A LONGITUDINAL MAGNETIC FIELD. Zolototrubov, I. M.; Kiselev, V. A.; Novikov, Yu. M.; Tolok, V. T. pp 165-71 of Issledovanie Plazmennykh Sgustkov. Sinelnikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

An attempt to develop a plasma source free of impurities by the use of a coaxial gun in a longitudinal magnetic field is discussed. The plasma gun and its operation is described, its energy source is a battery of condensers (1000 μF) working at 5 kV, the working gas is hydrogen injected by a fast-acting valve. When the gun is operated in the magnetic field, the discharge current plate appears. This, together with the observation of the plasma ejection velocity, indicates plasma drift typical of crossed electric and magnetic fields. High speed photography reveals that the plasma generated when the magnetic field is applied is much more uniform than in the absence of the field. Spectroscopic analysis shows that the magnetic field inhibits very strongly the appearance of electrode material impurities found in discharges without the external field. It is planned to overcome the insufficient ionization and low plasma velocity by increasing the electric power input and the modified magnetic field. (ATD)

3878 INVESTIGATION OF A DISCHARGE IN A PULSED PLASMA SOURCE. Kalmykov, A. A.; Pankratev, Yu. I.; Nozdrachev, M. G.; Shevchuk, B. A. pp 172-81 of Issledovanie Plazmennykh Sgustkov. Sinelnikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

The performance and characteristics of a plasma gun with a hot cathode are studied. The gun structure and operational parameters are described. The gun was operated with a pulsed magnetic field (20 μsec) during which a much shorter high-voltage pulse was applied to the cathode which was found to eject both ions and electrons. The collector received about one ampere of ion current during such pulsed operations. As in other guns, the ion acceleration occurred only during the first few tenths of a microsecond and the energy reached often exceeded the applied accelerating voltage. It was noted that when artificial transmission lines were used for the energy storage, plasma ejection occurred at each reflection of the wave thus forming a long train of plasmoids. The plasma properties were studied with a mass spectrometer, x-ray detectors and high-speed photography. The results for various pressure and current conditions are shown and analyzed in terms of the electric circuit interaction with a simple plasma model. (ATD)

3879 SOME EFFECTS OBSERVED DURING THE COLLISION OF SHOCK WAVES AND PLASMOIDS IN A SHOCK TUBE WITH INDUCTION DISCHARGE. Aseev, G. G.; Konovalov, V. G. pp 181-7 of Issledovanie Plazmennykh Sgustkov. Sinelnikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

Properties of strong colliding shock waves generated in quartz tubes by an electrodeless discharge were studied. The discharges formed shocks in argon and xenon gases. At higher Mach numbers, the shock front was quite plain and practically coincided with the plasma formed during the discharge due to short relaxation times. The shock wave velocity was found to decrease with initial pressure increase while the plasma velocity was found to have a maximum. This shows that some of the gas is ejected from the shock-forming region while further current flow produces the plasma behind the shock. Another set of experiments showed that the plasma was carrying currents that induced compressing fields which strongly affect the after-shock plasma and its behavior during the collision. This phenomenon should be considered in studies of strong shock wave propagation where other effects such as precursor formation are also important. (ATD)

3880 PLASMOID MOTION IN A FIELD-FREE REGION. Azovskii, Yu. S.; Guzhovskii, I. T.; Mazalov, Yu. P.; Pistryak, V. M. pp 203-12 of Issledovanie Plazmennykh Sgustkov. Sinelnikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

Plasma expansions in a field-free region were investigated by observing the density and energy profile of the plasma. A theoretical review of a simple plasma configuration is given and compared with the experimental results. The plasma was generated by a conical electrodeless discharge and injected into a 250 cm tube. The measurements were limited to the third and densest plasmoid (10^{11} cm^{-3} to 10^{12} cm^{-3}). The density distribution at any time was measured with a microwave interferometer. The measurements of ion and electron velocities and temperatures in all three dimensions are tabulated and the weak dependence on the initial density and type of expansion of these quantities is pointed out. A rather strong effect of neutral gas density became apparent from studying the expansion parameters as a function of the delay between the neutral gas injection into the plasma generator and the discharge of the capacitors to produce the plasma. However, the theoretical predictions indicate that the experimental results can serve as an estimate of plasma expansion. (ATD)

3881 THERMAL EXPANSION IMPULSE ACTUATOR IN PLASMA JET APPARATUS. Henins, Ivars; Marshall, J. Jr. (to U. S. Atomic Energy Commission). U. S. Patent 3,281,324. Oct. 25, 1966.

A linear impulse actuator is described for plasma research comprising a metallic stem connected through a switch to an electrical capacitor so that discharge of the capacitor through the stem results in an expansion shock wave. (AEC)

3882 APPARATUS FOR GENERATING AND ACCELERATING CHARGED PARTICLES. Hendel, Hans W.; Reboul, Theophile T. (to Radio Corp. of America). U. S. Patent 3,279,175. Oct. 18, 1966. Filed Dec. 19, 1962.

Methods and apparatus for electro-magnetically accelerating charged particles, and for generating a plasma and for accelerating that plasma, are described. (M.O.W.)

Production of Plasma

Refer also to abstracts 3661 and 3833.

3883 (AD-641854) PRODUCTION AND STUDY OF A CESIUM PLASMA IN THERMODYNAMIC EQUILIBRIUM. Final Report, May 17, 1963–May 16, 1966. (Lockheed Missiles and Space Co., Palo Alto, Calif. Research Labs.). Contract DA-31-124-ARO(D)-105. 23p. (AROD-4336-1; LMSC-2-78-66-1). CFSTI $3.00 cy, $0.65 mn.

Means for producing a plasma in thermodynamic equilibrium without externally applied potentials are described. A cesium plasma is produced in an almost completely closed container, the container being maintained at a high temperature. Due to the low ionization potential of cesium (3.87 eV), one can obtain plasmas of interesting densities and properties at temperatures from 1500 to 2500°K. Such plasmas have properties dependent only on temperature, the energy levels of cesium (strictly speaking of both neutral and ionized states), the work function of the container, and on the total amount of cesium present. (auth)

3884 ON A POSSIBLE MECHANISM OF THE APPEARANCE OF HIGH-ENERGY PARTICLES IN A COAXIAL PLASMA GUN. Timofeev, A. D.; Marinin, V. G.; Shevchuk, B. A.; Kalmykov, A. A. pp 156-65 of Issledovanie Plazmennykh Sgustkov. Sinelnikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

Experimental investigation of the mechanisms of production of high energy particles in a coaxial gun was studied using a framing camera for observation of the plasma, a Rogowski coil for the measurement of current densities and scintillation counters for x-ray detection. Analysis of the results shows that in those discharges where plasma formation alone was observed, the discharge remains symmetric. The symmetry is preserved with polarity change as well as in the operating regime where fast particles are generated. In the case of unstable discharges, the x-ray detector registered copious hard x rays. The instability leads to large changes of inductance which induce abrupt voltage changes on the electrodes. Time correlation of the voltage increase with x-ray emission indicates that the fast ions are generated by these instabilities. An analysis of the electrical circuit of the system with its time-varying load shows that sufficiently large accelerating voltages can occur at plasma densities at which instabilities occur. (ATD)

3885 CORRELATION VELOCITIES. Suchy, Kurt (Univ. of Maryland, College Park). Ann. Physik (7), 18: No. 1-2, 78-96(1966).

With the coefficients of a Taylor expansion of the correlation function $C(\vec{\xi},\tau)$ up to the second order in $\vec{\xi},\tau$ three (or four) velocities can be defined to describe the space–time behavior in a satisfying manner. They have a simple geometrical relationship among each other. The necessary measurements for the computation of these coefficients are discussed. (auth)

3886 PHOTON CORRELATIONS IN IONIZING LASER BEAMS. Gardner, J. W. (English Electric Co. Ltd., Whetstone, Eng.). Electron. Lett., 2: 397-8(Nov. 1966).

A previous communication proposed the Pólya distribution to describe photon correlations in ionizing laser beams. Results are reported here for a special case of the Pólya distribution (Furry distribution). Given independent evidence that the Furry distribution applies, the present results enable one to distinguish between different multiphoton ionization processes. (auth)

3887 EXISTENCE OF NEGATIVE BERYLLIUM AND MAGNESIUM IONS. Bethge, K.; Heinicke, E.; Baumann, H. (Univ., Heidelberg). Phys. Lett., 23: 542-3(Nov. 28, 1966).

On extraction of negative ions from a metal vapor plasma of a Penning discharge, the existence of Be^-, BeH^-, Mg^-, and MgH^- ions could be demonstrated. The currents produced were sufficient for an acceleration of these ions. (auth)

3888 STUDY OF THE LIGHT EMITTED AFTER THE "EXPLOSION" OF A GASEOUS IONIZED FILAMENT. Skowronek, Maurice; Cabannes, Francois (CNRS, Bellevue, France). Compt. Rend., Ser. B, 263: 485-8(Aug. 17, 1966). (In French).

The spectral luminescence of a preionized linear electric discharge of very-high-energy density was measured in the visible region. The luminescence temperature neighboring the true temperature at the beginning of the phenomenon was deduced. The variations in luminescence at the beginning of the discharge are interpreted by assuming that the plasma frequency attains the visible domain. The electron density is estimated to be $N = 10^{21}$ cm^{-3} and the temperature $T \cong 10$ eV. (tr-auth)

3889 THERMAL IONIZATION IN A MAGNETIC FIELD. Dubner, V. M. (Scientific Research Inst. of High Temperatures, USSR). Teplofiz. Vysok. Temp., 4: 286-8(Mar.-Apr. 1966). (In Russian).

An equation of thermal ionization of a low-temperature plasma in a constant uniform magnetic field is developed. For hydrogen and alkali metals this equation is $N_e N_i / N_a = (\alpha / \mathrm{sh}\,\alpha)\, K_\theta(T,V)$, where N is the number of electrons, K_θ is the conventional reaction constant independent of the magnetic field strength, T is temperature, and V is volume. If $N_e \ll N_a$, the effect of magnetic field on the ionization becomes negligible. (ATD)

3890 STABILIZED ARC COLUMN WITH AXIAL GAS FLOW. Pusmogarov, A. V. Teplofiz. Vysok. Temp., 4: 173-6(Mar.-Apr. 1966). (In Russian).

Experimental and theoretical analyses were made of the effect of axial gas flow in an arc discharge on the volt–ampere characteristics and radial temperature distributions in the arc column. The experiment was carried out for an electric arc in an argon plasma with the charge stabilized by a solid cylindrical wall with channel diameter 6 and 10×10^{-3} M, length 42 and 98×10^{-3} M, flow rate of 0.05 to 2.4×10^{-3} kg/sec, source strength 0.5 to 15 kV, and p = 0.1 to 0.2 atm. (tr-auth)

3891 THEORY OF A HIGH FREQUENCY VORTICAL DISCHARGE AT HIGH PRESSURE. I. Soshnikov, V. N.; Trekhov, E. S. Teplofiz. Vysok. Temp., 4: 166-72(Mar.-Apr. 1966). (In Russian).

On the basis of a qualitative analysis of the conditions which characterize an infinitely long cylindrical high-frequency vortical discharge at high pressure ($p \gg 0.1$ atm), a simple qualitative criterion is given for the presence of thermodynamic equilibrium. In this case, the theory of a vortical discharge leads to the simultaneous solution of Maxwell's equations (with the electrical conductivity as a function of the radius) and the heat conductivity equation. Numerical calculations are made for air at a temperature at the center of 6000 and 10,000°K, a pressure of 1 atm, and a field frequency of 50 Mc. The calculations establish the nonexistence, under these conditions, of the effect of the magnetohydrodynamic forces of the high-frequency magnetic field due to the discharge. Results of the calculations are shown in tabular and graphic form. (ATD)

3892 APPARATUS FOR GENERATING MASSES OF HOT IONIZED GAS AND AMPLIFYING RANDOM FLUCTUATIONS. Ferrari, Ronald Leslie; Reddish, Alan (to The M-O Valve Co., Ltd.). U. S. Patent 3,275,868. Sept. 27, 1966. Priority date Nov. 14, 1962, Great Britain.

A method is described for generating a mass of hot ionized gas in which a stream of gas ions is caused to travel over a considerable distance in proximity to a medium which is capable of propagating waves of a type which can interact with waves propagated along the stream of ions with a phase velocity directed in the same sense as, but of lower value than, the mean velocity of the stream. (M.O.W.)

3893 APPARATUS FOR PRODUCING A HIGH-TEMPERATURE PLASMA. Iwashita, Fumio (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1965-20830. Sept. 15, 1965. Filed Oct. 8, 1964.

In conventional high-temperature plasma-producing devices, the condensers of high capacity employed are usually of very high cost, and furthermore, since many ignitrons have to be operated at the high voltages, other accessories, such as the respective insulated transformers are required, making the overall construction very complicated. In the apparatus proposed here, these drawbacks are removed, and in addition, without high capacities of the condensers, the voltage applied to the discharge tube can be maintained sufficiently long. The apparatus consists of the following: the first and second condensers, charged by their sources; the switch and the primary-windings, connected in series to the first condenser; the switch and the primary windings, connected similarly to the second condenser; and the discharge tube in the form of a ring, having the secondary windings common to the two primary windings. The charges in the first and second condensers are discharged through the two primary windings, while closing the two switches. The voltages induced by the two primary windings are applied at the same time to the discharge tube, thus controlling the electric current in the tube. (NSA of Japan)

3894 DEVICE FOR PRODUCING A HIGH-TEMPERATURE PLASMA. Iwashita, Fumio (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1965-20480. Sept. 11, 1965. Filed June 20, 1963.

In this high-temperature plasma generator, without an elaborate mechanical opening-and-closing mechanism, the excess power in the condensers can be discharged with no fail at the desired time when the electric current through the coils becomes approximately zero. It consists of the following: a power source for charging the condensers; the 1st condenser charged by this power source; the 2nd condenser, connected in parallel through a high resistance to the 1st condenser; a discharge tube, wound with coils for plasma containment; a switch, which closes or opens the electric circuit for discharging the charge in the 1st condenser to the coils of the discharge tube; and a discharge gap, connected to the coils in parallel. The charge in the 1st condenser is discharged through the coils by closing the switch, and the discharge gap is discharged by the summed value of the terminal voltages of the 1st and 2nd condensers when the current through the coils becomes approximately zero. (NSA of Japan)

Stability of Plasma

Refer also to abstract 3584.

3895 (N-66-29297) INTERACTION BETWEEN ION BEAMS AND PLASMAS. Rowberg, R.; Wong, A. Y. (California Univ., Los Angeles. Dept. of Physics); Sellen, J. M. (TRW Systems, Redondo Beach, Calif.). Apr. 1966. 18p. (NASA-CR-75818; R-6). CFSTI $3.00 cy, $0.65 mn.

Preliminary results are reported on the interaction between a low energy cesium ion beam (1 to 30 eV) and a thermal cesium plasma (0.25 eV), and an attempt was made to determine the stability limits for ion acoustic waves due to this interaction. Experimental apparatus includes an ion gun, which is shown in a schematic of the system. It was pointed out that the beam density studied decreased as the beam velocity increased. The maximum beam density achieved was 10^{10} particles per cc, and the background plasma density ranged from 10^{9}/cc to 10^{11}/cc. Oscillations were found to propagate in the azimuthal direction and in the direction of the electron density gradient drift. Both the fundamental and the first harmonic of this wave were observed. In addition, a second oscillation was observed propagating in the azimuthal direction with about the same frequency as the drift wave. The longitudinal mode was also studied, and no interaction between the wave and the beam was found. (STAR)

3896 (N-66-29395) TWO-STREAM INSTABILITY IN GRAVITATING PLASMAS WITH MAGNETIC FIELD AND ROTATION. Talwar, S. P. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Mar. 1965. 25p. (NASA-TM-X-55176; X-641-65-97). CFSTI $3.00 cy, $0.65 mn.

The problem of instability in contrastreaming streams of plasma or self-gravitating gas clouds is investigated for general propagation direction, using moment equations. A uniform rotation is also included in view of its astrophysical importance. Conditions for instability (monotonic or growing wave) are derived. It is found that the classical Jeans' wavelength for fragmentation of interstellar medium is considerably diminished due to interstreaming speeds. For a non-gravitating plasma it is concluded that perturbations propagating normal to the interstreaming direction lead to a monotonic instability. This instability, though characterized by a small growth rate, should be possible to observe in laboratory plasmas if dimensions are suitably chosen to eliminate the conventional electrostatic two-stream instability. (auth)

3897 (SU-IPR-106) STUDIES OF PLASMA OSCILLATIONS. Quarterly Status Report No. 27, June 1, 1966–August 31, 1966. Crawford, F. W. (Stanford Univ., Calif. Inst. for Plasma Research). Sept. 1966. Contract AT(04-3)-326. 40p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Investigations were made of instabilities occurring in discharges at pressures of the order of 1 mtorr, with the intention of determining: where and how they are excited in the discharge; how perturbations due to the instabilities propagate through the plasma; and whether it is possible to eliminate any or all of the sources of instability. (M.O.W.)

3898 (AEC-tr-6834) ASYMPTOTIC METHODS OF HYDRODYNAMIC STABILITY THEORY. Zaslavskii, G. M.; Moiseev, S. S.; Sagdeev, R. Z. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). Translated from a report. 28p. JCL $2.60 fs, $1.04 mf.

An extensive description is given of plasma stability theory. (M.O.W.)

3899 POSSIBILITY OF ANOMALOUS TRANSFORMATION OF WAVES IN PLASMA. Moiseev, S. S. Zh. Prikl. Mekh. Tekh. Fiz., No. 3, 3-7(May-June 1966). (In Russian).

Normal oscillations are independent in the approximation of the geometric optics in a feebly heterogeneous medium. The approximation is upset near points where the wave vector k(x) either returns to zero, or where the wave vectors corresponding to various types of oscillations coincide. When the vicinities are small these points cannot be separated into individual, normal oscillations, as is the case, for example, when the existence of "points of intersection for the solution" result in the appearance of yet a new wave with other dispersion properties, in addition to the wave falling from infinity. Cases of the "birth" of new waves considered in the past have reduced to an exponentially small transformation factor, as well as to the absence of reflected waves. The appearance of reflected waves for the intersection of solutions is discussed, as well as the appearance of transient waves with large transformation factors. Note is made of the fact that a large transformation is possible between ordinary and extraordinary waves. It can be shown that in rarefied plasma the anomalous transformation is possible if the Larmor frequency corresponding to the projection of the magnetic field in the direction the waves are propagated is on the order of the frequency of these waves. The question of wave transformation can be proven to be material to the problem of plasma stability. (ATD)

3900 DEVELOPMENT OF INSTABILITY IN A PLASMOID UPON INJECTION IN AN AXIALLY SYMMETRIC MAGNETIC FIELD. Kalmykov, A. A.; Trubchaninov, S. A.; Naboka, V. A. pp 89-102 of Issledovanie Plazmennykh Sgustkov. Sinelnikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

The investigations were made with a coaxial plasma gun which produced hydrogen plasmoids of density up to 10^{13} cm^{-3} and velocities (7 to 8) $\times 10^{7}$ cm/sec. The magnetic field was produced at a distance (100 cm) sufficient for attenuation of the currents captured by the plasmoid. In view of the fact that the front part of the plasmoid did not have sufficient luminosity, the structure of the plasmoid was investigated with a plasmascope. The field distribution was measured with the aid of probes. The results showed that the behavior of the plasmoids in the nonuniform magnetic field was very similar to that occurring during rapid compression of the plasma in a θ pinch, and the test results are interpreted in light of this phenomenon. The possible causes of the instability of the plasmoid upon entering the axially symmetric field are discussed and are found to consist of reflection of part of the electrons on entering the magnetic field and the development of a radial electric field. It was also noted that the injection can be accompanied by rotation of the plasma, which may hinder the injection of plasma in magnetic traps of either mirror or acute-angle geometry. (ATD)

3901 STABILIZATION OF PLASMOID BOUNDARIES IN TRAVERSAL OF CORRUGATED MAGNETIC FIELDS. Kalmykov, A. A.; Tereshin, V. I.; Chebotarev, V. V. pp 112-18 of Issledovanie Plazmennykh Sgustkov. Sinelnikov, K. D. (ed.). Kiev, Naukova Dumka, 1965. (In Russian).

The results indicate that corrugated magnetic guiding fields can replace high-frequency stabilization of a plasmoid surface. The period of corrugation in the guiding fields was 10 cm, which at a plasma velocity of 2×10^7 cm/sec corresponded to a frequency of 2 Mc. The modulation amplitude was about 15%—sufficient to stabilize the instability leading to a spiraling of the plasma. This is demonstrated by a plasmascope adapted for pulsed operation. When the modulation amplitude reached 25% of the constant guiding field, some assymetry of plasma boundary was observed. At higher plasma velocity, the corrugated field failed to stabilize the plasma and tongue-like protuberances were observed. Energy loss measurements show that some 20% of the energy remained in the plasmoid for long travel distance. (ATD)

3902 HYDRODYNAMIC DRIFT-DISSIPATIVE INSTABILITIES OF A PLASMA WITH NON-UNIFORM TEMPERATURE. Baikov, I. S. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 4: 201-4(Oct. 15, 1966).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 4: 299-302(Oct. 15, 1966).

Moiseev earlier discussed the lf drift instability in an inhomogeneous plasma with collisions and the important role that longitudinal ion motion plays in its development. It is shown here that allowance for the plasma temperature and viscosity inhomogeneities leads to the appearance of a number of new lf instabilities. (M.O.W.)

3903 STATISTICAL ACCELERATION OF PARTICLES IN A TURBULENT PLASMA. Tsytovich, V. N. (Lebedev Inst. of Physics, Moscow). Usp. Fiz. Nauk, 89: 89-146(May 1966). (In Russian).

The theory of plasma instabilities, especially under outer-space conditions, and the initiation of such instabilities by statistical acceleration mechanisms is reviewed. Various applications of the statistical theory, which is an extension of the theory of weakly turbulent plasma and which includes the Fermi acceleration mechanism as a special case, are discussed both for astrophysical problems and for the possible interpretation of numerous laboratory experiments. The general characteristics of statistical acceleration are discussed and information is presented on plasma turbulence and on mechanisms of plasma generation, statistical changes in the states of the particles in a plasma, acceleration of plasma particles by Langmuir oscillations and by hf transverse waves, the spectra and average energies of the accelerated particles, and the efficiencies of various acceleration mechanisms. This is followed by the theory of statistical acceleration, with emphasis on the relative role of hf and lf turbulent pulsations, the limitations imposed on the oscillation intensity, the limiting transition of the statistical acceleration to the particular case of Fermi acceleration, and the role of nonstationary turbulent pulsations. Applications of acceleration mechanisms, including applications connected with acceleration of particles under laboratory conditions and astrophysical applications in connection with radio emission from quasars, acceleration of electrons and ions in the radiation belts, and acceleration of cosmic rays are described. (ATD)

3904 EXPERIMENTAL INVESTIGATION OF THE INSTABILITY OF AN INHOMOGENEOUS PLASMA. Vlasov, M. A. Zh. Eksp. Teor. Fiz., 51: 715-23(Sept. 1966). (In Russian).

Results are presented of an investigation of the instability of a plasma produced by a low-pressure arc discharge in magnetic fields up to 3000 Oe and at pressures from 4×10^{-4} to 10^{-2} torrs. Near critical magnetic field strengths such an instability is accompanied by formation of torches which are ejected from the arc column and rotate stationarily in the ion direction. With variation of the magnetic field the stationary state of the rotation ceases and for $H > 2000$ Oe the plasma goes over to the turbulent state. The transverse diffusion coefficient $D_\perp$ and characteristic lifetime of disturbances in the turbulent state γ' are estimated for these conditions. It is found that $D_\perp$ is of the same order of magnitude as the Bohm diffusion coefficient and γ' as the drift frequency. An expression for the torch rotation frequency is obtained on basis of a qualitative model and found to satisfactorily agree with the experimental results. (auth)

3905 EFFECT OF A RADIAL ELECTRIC FIELD ON THE INSTABILITY OF AN INHOMOGENEOUS PLASMA. Vlasov, M. A.; Krivtsov, V. A. Zh. Eksp. Teor. Fiz., 51: 730-9(Sept. 1966). (In Russian).

The effect of a radial electric field E_r on the instability of an inhomogeneous plasma produced by an arc discharge in an equipotential volume is studied. It is shown that a change of the magnitude of E_r results in a change of the critical magnetic fields, and a change of the sign of the electric field is accompanied by an abrupt change of the plasma from one unstable state to another. This transition occurs during a time which is of the order of magnitude of the inverse increments γ of the instability studied. By changing the direction of an electric field of frequencies of the order of γ it was possible to stabilize the plasma, study the dependences of the increment on the discharge parameters and estimate their absolute magnitude which was found to be of the order of the drift frequencies. (auth)

Thermonuclear Processes

3906 PROGRESS TOWARD FUSION POWER. Fowler, T. K.; Post, Richard F. Sci. Amer., 215: No. 6, 21-31(Dec. 1966).

Research developments toward the goal of fusion power are discussed. Powerful concepts such as the magnetic-well principle and short circuit by magnetic shear, and guidelines from thermodynamics, are discussed. (M.O.W.)

Shielding

3907 (GAMD-6775) MUSCAT: A FORTRAN IV VIEW FACTOR SHIELDING CODE. Gerber, Mary J.; Roos, Bernard W. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Dec. 6, 1965. Contract AT(04-3)-633. 132p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

MUSCAT is a FORTRAN IV program for the IBM 7044 to compute the incident scattered neutron currents as a function of position within the following cavities: (1) the cavity formed by two truncated concentric spheres, (2) the cavity between two concentric circular cylinders, and (3) a cylindrical cavity. A compilation is presented of the view factors and a description of the code for the case of two concentric cylinders and the case of a cylindrical cavity. (M.O.W.)

3908 (JINR-P9-2933) OSLABLENIE V BETONE POTOKA NEITRONOV, ISPUSKAEMYKH POD UGLOM 90 DEG K NAPRAVLENIYU PERVICHNOGO PUCHKA PROTONOV SINKHROFAZOTRONA NA 10 GeV. (Attenuation by Concrete of the Neutron Flux Emitted at 90 deg to the Direction of the Primary Proton Beam of the 10 GeV Synchrophasotron). Aleinikov, V. E.; Lebedev, V. N.; Mantseva, V.; Salatskaya, M. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1966. 15p. (In Russian). Dep. mn.

Information is given about the attenuation in 3m-thick concrete layers of high and low energy neutrons which are generated by the Be or Cu target and emitted at 90° to the direction of the 10 GeV primary proton beam bombarding the target, i.e., in the geometry of annular accelerators. It is shown that these results can be applied to the accelerators with the energy up to some hundreds of GeV. Information is given also about the space-angular distributions of nucleons and π-mesons. (auth)

3909 (ORNL-P-2672) CALCULATIONS USING THE ALBEDO CONCEPT OF THE SUBCADMIUM FLUX ALONG THE CENTER LINE OF A STRAIGHT, A TWO-LEGGED, AND A THREE-LEGGED SQUARE CONCRETE DUCT ARISING FROM INCIDENT SUBCADMIUM NEUTRONS AND COMPARISON WITH EXPERIMENT. Maerker, R. E.; Muckenthaler, F. J. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 29p. (CONF-661001-34). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 14th Conference on Remote Systems and Technology, Pittsburgh, Pa.

A brief description of the calculation program is presented and the assumptions inherent in utilizing the albedo concept described. The results are described and compared with experimental ones. (M.O.W.)

3910 (WAPD-T-1932) ENERGY BUILDUP FACTORS IN WATER FOR VERY DEEP PENETRATIONS FOR A 6-MeV PLANE ISOTROPIC GAMMA SOURCE. Lois, L. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Aug. 1966. Contract AT(11-1)-Gen-14. 9p. (CONF-661001-32). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 14th Conference on Remote Systems and Technology, Pittsburgh, Pa.

A new formulation for the solution of the linearized Boltzmann transport equation was applied to the gamma-ray transport problem for multilaminar arrays in slab geometry. A program based on this method was constructed and applied to the problem of gamma-ray transport in slab geometry. The slowing-down problem is handled by the group technique. The energy range is divided into regions so that the cross sections are almost constant within each region. Then a sequence of monoenergetic problems is solved for each group. (M.O.W.)

3911 (ORNL-tr-1411) SHIELDING OF HIGH-ENERGY ELECTRONS: THE NEUTRON AND MUON COMPONENT. Bathow,

G.; Freytag, E.; Tesch, K. (Deutsches Elektronen-Synchroton, Hamburg (West Germany)). Translated for Oak Ridge National Lab., Tenn., from report DESY-66/18. 15p. Dep. mn. JCL $1.60 fs, $0.80 mf.

Heavy concrete shielding measurements were extended to thickness from 200 to 400 cm using 4- and 6-GeV electron beams. High-energy neutrons and secondary low-energy neutrons as well as muons were measured. Flux densities, attenuation coefficients, and lateral distributions are given. The experimental results agree with the estimates. (auth)

3912 INVESTIGATION OF GAMMA-RAY BACKSCATTERING FOR BROAD RADIATION BEAMS. Koch, S. (Technical Univ., Dresden). Isotopenpraxis, 2: 354-7(Sept. 1966). (In German).

Relations between the backscattering rate and the extent and the properties of the scattering material have been studied. The measurements were carried out using the radioisotopes ^{60}Co, ^{137}Cs, ^{203}Hg, ^{141}Ce, and ^{170}Tm. The point isotropic sources have had contact with the plane boundary surfaces of the scatterers. (auth)

Solid-State Physics

Refer also to abstracts 3496, 3546, 3556, 3733, 3797, 4182, and 4286.

3913 (INR-745/II/PS) INTENSITY AND RESOLUTION IN THE TIME-OF-FLIGHT POWDER DIFFRACTOMETRY. Buras, B.; Holas, A. (Institute of Nuclear Research, Warsaw (Poland)). Aug. 1966. 60p. Dep.

As has been shown in recent years, the neutron time-of-flight method can be applied to structure analysis of powdered crystals. Mathematical expressions were developed allowing calculation of the integrated intensities and half-widths of reflections as functions of parameters of the experimental setup, i.e., the scattering angle, the parameters of the chopper, the flight path, the shape and dimensions of the sample, and the dimensions of the counter, collimators, etc. Based on these expressions a procedure of optimization of the experimental conditions were developed. Using this procedure, several experimental arrangements are optimized and examples are given. (auth)

3914 (N-66-29980) RECOMBINATION LIFETIMES IN GAMMA-IRRADIATED SILICON. Hewes, Ralph Allan (Illinois Univ., Urbana. Dept. of Physics). June 1966. 188p. (NASA-CR-76090). CFSTI $3.00 cy, $0.65 mn.

Thesis.

The small-signal recombination lifetimes of minority carriers were measured as a function of temperature in silicon before and after irradiation at room temperature by cobalt-60 γ rays. The resistivity of the boron doped samples ranged between 10 and 5000 ohm-cm, and the resistivity of the phosphorus-doped samples was between 20 and 220 ohm-cm. Both crucible and floating zone grown materials were investigated. The experimental results indicated: (1) the recombination centers active in n-type silicon are not the same as those active in p-type silicon, (2) the recombination centers dominant in float-zoned material appeared to anneal at lower temperatures than those dominant in crucible-grown material, (3) the defects controlling the lifetime in n-type material appeared to be the A and E centers, located at $E_c - 0.17$ and $E_c - 0.4$ eV, respectively, (4) the defects controlling the lifetime in p-type material, appeared to have energy levels at $E_v + .18$ eV and $E_c - .3$ eV, and (5) there appeared to be no strong dependence of the introduction rates for the defects on resistivity. Data are also given to verify the Shockley-Read formula. (STAR)

3915 EFFECT OF PRELIMINARY γ IRRADIATION ON THE ELECTRIC PROPERTIES OF SINGLE CRYSTALS. Zavadovskaya, E. K.; Chernyshev, V. A. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 2, 155-7(1966). (In Russian).

Conductance σ, tangent of the dielectric loss angle tan δ, and specific inductive capacitance ϵ of CaF_2 single crystals, both irradiated from a ^{60}Co source and nonirradiated, were investigated. The absorbed irradiation dose was 1.66×10^8 rad. Conductance σ was measured by means of a dc amplifier with an electric field intensity of 500 V/cm. Accuracy of σ measurements was 20%. Tan δ and ϵ were measured by means of an unbalanced bridge in the 100 to 20,000 cps range. Measurement accuracy was 20% for the tangent of the dielectric loss angle and 0.3% for specific inductive capacitance. Specimen capacitance was within 7 to 12 pf. The specimens were 0.8 to 1.1 mm thick. Platinum electrodes were deposited by cathode spraying in a vacuum. The same specimens were used for measuring σ, tan δ, and ϵ. Measurements were taken in a vacuum (8 to 5) $\times 10^{-4}$ mm Hg at temperatures ranging from 20 to 450°C. Curves of the dependence of conductance on temperature show discontinuity in the range 90 to 130°C. For irradiated crystals conductance increases up to the discontinuity point, beyond which conductance is equal to that of nonirradiated crystals. Curves for the dependence of tan δ on temperature show regions both of conductance and relaxation losses. ϵ increases slightly and almost linearly with an increase in temperature. It was also noted that preliminary irradiation results in a decrease both of tan δ and ϵ, and in an increase in conductance. (ATD)

3916 STORING OF LIGHT SUM IN LiH PHOSPHORS. Shulgin, B. V.; Gavrilov, F. F.; Sazykin, V. V. (Ural Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Yaved., Fiz., No. 1, 189(1966). (In Russian).

Results of an investigation of the thermoluminescence curves of the blue luminescence of LiH when exposed to ultraviolet from a mercury lamp, to 15-MeV radiation from a betatron (beta and gamma), to 5.12-MeV α particles, and to $(n + \gamma)$ radiation from a Ra-Be source are presented. Paraffin 6 cm thick was used as the neutron moderator. The crystals were heated in darkness to 300°C and the irradiation was at room temperature in a vacuum. The radiation was recorded with a photomultiplier, amplifier, and automatic recorder. The time of irradiation of the crystals before plotting the de-excitation curves was 10 to 15 days for neutrons and α particles, 10 to 15 hours for the betatron radiation, and 20 to 30 minutes for the uv irradiation. The temperature was raised at a rate of 35 to 40°/min. The de-excitation curves show three peaks at 80 to 90°C, 140 to 150°C, and 230 to 300°C. The highest peak has a superimposed structure. When exposed to ultraviolet all three types of electron traps corresponding to the peaks are filled approximately uniformly. When exposed to neutrons, α particles, and betatron radiation, it is essentially the deep traps which are filled (peak at 230 to 300°C). Having blue luminescence and being capable of storing the light sum, LiH is of great interest as a detector of ionizing radiation. (auth)

3917 INFLUENCE OF GAMMA RADIATION ON THE MICROHARDNESS OF SILICON. Krivov, M. A.; Potakhova, G. I.; Rybkina, L. P. (Siberian Physicotechnical Inst., USSR). Izv. Vyssh. Ucheb. Yaved., Fiz., No. 1, 190-1(1966). (In Russian).

The microhardness of n- and p-type silicon was measured before and after exposure to different doses of γ radiation. Since γ radiation can produce additional dislocations and change the carrier density, which in turn influences the microhardness, these quantities were also measured simultaneously with the microhardness. The samples of each type used for all the investigations were cut from a single plate. In all cases the microhardness increased with increasing radiation dose. The change in microhardness can be attributed to three causes: change in carrier density, appearance of displaced atoms, and change in dislocation density. Hall-effect measurements showed that the change in carrier density does not exceed 6 to 8% and is comparable with the measurement error. The displaced-atom density increases in accordance with theory in proportion to the integral γ-quantum flux, and the change in the dislocation density is shown. It is concluded that the increase in microhardness is due to the increase in number of defects in the structure, caused by a simultaneous increase in the dislocation density and the appearance of a large number of displaced atoms. (ATD)

3918 SOME MECHANICAL AND OPTICAL PROPERTIES OF GAMMA-IRRADIATED ALPHA Al_2O_3 SPHERES SUBJECTED TO 30-KILOBARS PRESSURE. Gabrysh, A. F.; Lo, Mei-kuo; Pan, Lin-sin; Eyring, H. (Univ. of Utah, Salt Lake City). J. Franklin Inst., 282: 135-46(Sept. 1966).

Absorption of light along several axes was studied in single-crystal α-Al_2O_3 spheres. Spectra for control spheres were compared to spectra from specimens treated with ^{60}Co γ radiation and 30-kbar pressure. The spectra showed an axis-dependence regularity with regard to several γ-ray-induced peaks. Light transmission measurements showed a pressure dependence for γ-ray-induced peak intensities and for the resulting absorbing-center concentrations as calculated using Smakula's formula. Three pressure-induced basal (0001) slips along the $[11\bar{2}0]$ direction had appreciable width. The wavelengths of some of the absorbing-center peaks appear also in connection with other phenomena in Al_2O_3 crystals. A peak maximum at 260 mμ was observed on control and γ-irradiated specimens and at 260 mμ and about 230 mμ after oxygenation, hydrogenation, and solarization. The 231-mμ maximum appears to be dependent on crystal orientation (i.e., C axis). It appeared strongly after γ irradiation, along all axes. The shifts appeared after ϵither γ irradiation and/or pressure. A slight amount of absorption-peak bleaching was observed in a newly irradiated crystal kept in the dark until the time of the measurements. (BBB)

3919 GAMMA-RAY-INDUCED DEFECT BLEACHING IN PRESSURE DEFORMED SINGLE CRYSTAL ALPHA Al_2O_3. Gabrysh, A. F.; Eyring, H.; Lo, Mei-kuo; Hardy, S.; Yates, J. (Univ. of Utah, Salt Lake City). J. Franklin Inst., 282: 147-54 (Sept. 1966).

The rates of bleaching of color centers induced by ^{60}Co γ radiation in single-crystal α Al_2O_3 were studied along the C axis after the crystal was subjected to 30-kbar pressure, which produced slips on the basal (0001) and (1$\bar{2}$10) planes. Bleaching was effected by bathing the sample with radiation from a mercury lamp. Three absorbing centers with peaks occurring at 415, 260, and 228 mμ showed different bleaching rates. The 415-mμ peak bleached out faster than the 260-mμ peak but slower than the peak at 228 mμ. The curves were analyzed in terms of a model wherein the absorbing centers were distributed continuously and uniformly with a band below the conduction band. The best curve fits were obtained by using a second-order process of the form $N(t) = N_0[b/(b + t)]^m$. The absorbing-center concentrations, N, were calculated using Smakula's formulas. A model for the observed effects is described and diagramed. (TSS)

3920 RADIOELECTRET EFFECT IN PARAFFIN WAX. Gomulkiewicz, J. (Higher Agricultural Coll., Wroclaw). Acta Phys. Pol., 30: 549-57(Oct, 1966).

A description and results of experiments on the influence of temperature and uv light on the charge of radioelectrets from paraffin wax are given. It was found that the radioelectret charge decreases with the increase of temperature at which the samples are subjected to ionizing radiation and stored before forming. Illumination with uv light before forming of irradiated samples results in an increase of electret charge, whereas illumination after forming leads to a considerable decay of the charge. The spatial distribution of free charge and internal polarization in radioelectrets formed from paraffin wax has also been determined. (auth)

3921 DYNAMIC THEORY OF X-RAY INTERFERENCE ON IDEAL CRYSTALS NOT LIMITED TO TWO DIMENSIONS (CYLINDERS AND SPHERES). Schuermann, H. W.; Farwig, P. (Univ., Muenster, Ger.). Z. Phys., 197: 356-66(1966). (In German).

Scattering of a plane wave (x-ray) from cylinder and sphere with perfect grating is treated by means of an integrodifferential equation. Approximate formulas for the scattered power are derived. (auth)

3922 ESR ABSORPTION SPECTRA OF TWO PHOSPHOROUS DEFECT CENTERS IN IRRADIATED SINGLE-CRYSTAL CALCITE. Serway, R. A. (Illinois Inst. of Tech., Chicago, IIT Research Inst., Chicago); Marshall. S. A. J. Chem. Phys., 45: 4098-4104(Dec. 1, 1966).

Two paramagnetic defect centers associated with phosphorous impurities and corresponding to $S = \frac{1}{2}$ and $I = \frac{1}{2}$ have been observed in irradiated single-crystal calcite. One center, which is produced by γ irradiation, has an ESR absorption spectrum that consists of six doublets at 77°K and below, each exhibiting orthorhombic symmetry with spin-Hamiltonian parameters given by $g_{xx} = 2.0072$, $g_{yy} = 2.0033$, $g_{zz} = 2.0122$, $A_{xx} = 52.53$ Mc, $A_{yy} = 56.16$ Mc, and $A_{zz} = 52.21$ Mc, where the relation between the x, y, z coordinates and those of calcite is discussed. As the temperature is raised, the lines of this spectrum are observed to broaden and at about 150°K the spectrum collapses into one doublet pattern, which exhibits symmetry about the calcite (111) direction suggesting that the coordinates of the defect center undergo some form of motion whose mean z axis is parallel to the calcite (111) direction. This behavior is attributed to thermally induced reorientations of the defect between six magnetically inequivalent sites. The activation energy for this reorientation is estimated to be 0.10 eV from low-temperature line-broadening data. An electron–nucleus double-resonance absorption spectrum observed at 4.2°K demonstrated that the doublet is associated with ^{31}P. It is concluded that the center giving rise to this ESR spectrum is the PO_3^{2-} molecule–ion. The second defect center is produced by neutron irradiation and has an ESR absorption consisting of a doublet pattern that exhibits symmetry about the calcite (111) direction. This center is stable up to about 300°K and at 77°K has spin-Hamiltonian parameters given by $g_{||} = 2.00165$, $g_\perp = 2.00162$, $A_{||} = 2293.2$ Mc, $A_\perp = 1789.6$ Mc, and $g^n\beta^n/g\beta = -0.000608$. This spectrum is identified with the PO_3^{2-} molecule–ion believed to occur as a substitution for the carbonate ion. (auth)

3923 RADIATION DAMAGE RESULTING FROM NUCLEAR FISSION IN LiF SINGLE CRYSTALS. Van den Bosch, A. (Studiencentrum Kernenergie, Mol, Belg.). Bull. Soc. Belge Phys., Ser. IV, No. 5, 332-7(1965). (In Dutch).

The nuclear reaction $^6Li(n,\alpha)^3H$ is the predominant cause of radiation damage in single crystals of lithium fluoride when irradiated with thermal neutrons. The total range of the fission products is small (some 10^{-3} cm) so that the distribution of defects, created at one fission, is unlikely to be homogeneous in a macroscopic sample. With the assumption that an elementary volume per fission exists, which contains all the defects formed at one event, an order of its magnitude can be deduced from the obtained data. In the optical absorption spectrum taken on crystals that received a dose smaller than 10^{14} neutrons/cm^2, the F band is predominant. A study on its reproducibility leads to the conclusion that the band formation depends on the previous history of the sample. A volume effect in the annealing of γ-irradiated LiF crystals is found. (auth)

3924 THE CRYSTALLINE STRUCTURE OF THE COMPOUND $U_{20}C_3Si_{16}$. Blum, Pierre Lazare; Silvestre, Georges (CEN, Grenoble, France). Compt. Rend., Ser. B, 263: 709-11 (Sept. 12, 1966). (In French).

A study of the ternary diagram U–C–Si revealed the existence of a second ternary combination with formula $U_{20}C_3Si_{16}$. The structure of this compound determined by the use of monocrystals was found to be hexagonal and it belongs to the group 6/m m m. The parameters of the lattice are a = 10.385 Å and C = 8.013 Å; Z = 1. The positions of the uranium and silicon atoms were established from the reflection intensities. The positions of the carbon atoms were deduced from steric considerations, along with the positions allowed by the space group. (tr-auth)

3925 MAGNETIC PROPERTIES OF CERIUM–SCANDIUM ALLOYS. Chechernikov, V. I.; Pechennikov, A. V.; Pop, Iuliu (Moscow State Univ.). Fiz. Metal. Metalloved., 21: 937-9 (June 1966). (In Russian).

Magnetic susceptibility of Ce–Sc alloys as a function of temperature was studied with seven alloys containing 9, 17, 41, 49, 65, 80, and 90 wt % Sc and with pure cerium and scandium—all annealed at 500°C for 240 hr and pendulum balance measurements made under vacuum with residual pressure of 10^{-4} mm Hg. The results showed that the magnetic susceptibility of alloys with a high content of Ce depends on the localized 4f electrons. The effects of the usually temperature-independent χ_{NK} term becomes pronounced only at high temperatures, when the contribution of χ_{NK} is identical to localized electron paramagnetism. In alloys with a high content of Sc, the collective electron system plays an important part, which results in production of the d-electron. (R.V.J.)

3926 MAGNETIC PROPERTIES OF $DyAl_2$ AND $NdAl_2$. Nereson, N.; Olsen, C.; Arnold, G. (Los Alamos Scientific Lab., N. Mex.). J. Appl. Phys., 37: 4575-80(Nov, 1966). (LA-DC-7844).

The magnetic properties of two dialuminides, $DyAl_2$ and $NdAl_2$, were investigated by neutron diffraction and susceptibility measurements. Both compounds show Curie–Weiss behavior in the paramagnetic region and are basically ferromagnetic below Curie temperatures of 62°K and 65°K, respectively. At low temperatures, the compound $NdAl_2$ is a pure ferromagnet, whereas $DyAl_2$ is almost completely ferromagnetic, but has the additional property of a weak antiferromagnetic ordering. The susceptibility measurements show an effective moment per molecule of 9.7 ± 0.1 and 3.1 ± 0.05 μ_B for $DyAl_2$ and $NdAl_2$, respectively. The neutron-diffraction data show a rare-earth-ordered saturation moment of 9.1 ± 0.4 and 2.5 ± 0.1 μ_B on the Dy and Nd atom sites, respectively. The Al atom sites exhibit no measureable moment within the limits of experimental detection (0.5 μ_B). Both compounds show a temperature-dependent magnetic ordering process, which obeys a Brillouin function. The experimental magnetic form factor for both the Dy^{3+} and Nd^{3+} ions diminishes more rapidly with increasing $(\sin\theta)/\lambda$ than present theory postulates. (auth)

3927 ELECTRICAL CONDUCTION IN THORIA AND THORIA–YTTRIA AS A FUNCTION OF OXYGEN PRESSURE. Bauerle, J. E. (Westinghouse Research Labs., Pittsburgh). J. Chem. Phys., 45: 4162-6(Dec. 1, 1966).

The electrical conductivity of pure ThO_2 and some $ThO_2-YO_{1.5}$ solid solutions was measured at 1000°C under partial O_2 pressures ranging from 1 to $10^{-14.6}$ atm. For all specimens the conductivity is well described by $\sigma = \sigma_i + \sigma_2 p_{O_2}{}^{1/4}$. The term σ_i is interpreted as an oxygen ion vacancy conductivity fixed by the cation composition of the sample. The term $\sigma_2 p_{O_2}{}^{1/4}$ is interpreted as a positive hole conductivity arising from the incorporation of excess oxygen into lattice vacancies via the reaction $\frac{1}{2}\,O_2 + v_{O^{2-}} \rightleftharpoons O^{2-} + 2h$, where $v_{O^{2-}}$ is an oxygen ion vacancy, O^{2-} is an oxygen ion, and h is a hole. (auth)

3928 REMOVAL OF SINGLE INTERSTITIALS FROM IRRADIATED PLATINUM. Galligan, J. M. (Columbia Univ., New York); Attardo, M. J. Contract AT(30-2)-Gen-16. Phys. Rev. Lett., 17: 1173-5(Dec. 5, 1966). (BNL-10654).

High-purity platinum wire 2 mm in diameter was annealed at 1200°C for 48 hours in vacuum of 10^{-7} torr. The annealed wire was then irradiated to an integrated neutron flux of 10^{18} nvt (E ≥ 1.45 MeV) in two batches, one at 100°K and the other at 340°K. Arguments are given that enhanced bright spots observed in the

Pt, using a field-ion microscope operated at 4.2°K, are due to single interstitials. (M.O.W.)

3929 ELECTRON-NUCLEON DOUBLE RESONANCE OF F CENTERS IN KCl. Deigen, M. F.; Ruban, M. A.; Ishchenko, S. S.; Barin, N. B. (Inst. of Semiconductors, Academy of Sciences, Ukrainian SSR). Zh. Eksp. Teoret. Fiz., 51: 1014-22(Oct. 1966). (In Russian).

Hyperfine and quadrupole interaction between KCl F centers and the crystal lattice nuclei are studied by the electron-nuclear double resonance (ENDOR) technique. The angular dependences of the ENDOR frequencies at liquid nitrogen temperature are investigated in detail for ions of the III–VI, VIII, IXa and XIII shells surrounding the vacancies. Quadrupole splitting in the III shells is detected and measured. The general form of the spin Hamiltonian in which deviation from axial symmetry is taken into account is employed for describing the experimental results. All parameters of the spin Hamiltonian are determined. (auth)

3930 EFFECTS OF X-RAY IRRADIATION ON THE SELF-FRICTION OF POTASSIUM CHLORIDE. Jirgal, G. H. Jr.; Zwicker, Earl F. (Illinois Inst. of Tech., Chicago). Contract AT(11-1)-1052. J. Appl. Phys., 37: 4358-63(Nov. 1966). (COO-1052-1).

The forces of static and sliding friction between mechanically polished x-irradiated KCl were found to satisfy the equations: F (static) = $AN^{\frac{1}{3}} + BN$ and F (sliding) = $B'N + D'N^{\frac{1}{3}}$, where F is the force of friction, N is the normal force, and A, B, B′, and D′ are numerical coefficients. Various models of friction were examined, and it is shown that both the functional relationships between friction and the normal force and between the changes in the numerical coefficients and the F-center concentration are consistent with a modification of the theories of Bowden and Tabor and of Rabinowicz. In this modification, the coefficients are given by $A/B = MW/p^{\frac{1}{3}}$, $B = B' = s/p$, and $D' = M'p^{-\frac{1}{3}}$, where s is the shear strength of the junctions of the contacting asperities, p is the flow pressure of the asperities, W is the work of adhesion per unit area, and M and M′ are numerical constants. The changes of the frictional coefficients A/B, B, B′, and D′ were proportional to the square root of the F-center concentration induced by the x irradiation and were consistent with the theory of defect hardening proposed by Fleischer and the flow stress experiments of Nadeau and of Sibley and Sonder. (auth)

3931 ROOM-TEMPERATURE LATTICE SPACINGS OF SOME INTRA RARE EARTH BINARY SYSTEMS. Harris, I. R.; Koch, C. C.; Raynor, G. V. (Univ. of Birmingham, Eng.). J. Less-Common Metals, 11: 436-54(Dec. 1966).

Lattice spacing measurements have been made for a selection of alloys in the Gd–Ce, Gd–Pr, Y–Ce, and Y–Pr systems. The behavior of cerium in solid solutions is found to be anomalous as compared with that of praseodymium and the results are discussed in terms of the tendency for cerium to adopt the same valency as that of the solvent. The hypothetical Sm-type and double hexagonal forms of gadolinium have a smaller atomic volume than the close-packed hexagonal form and this phenomenon is probably related to the loss of residual ferromagnetism. The various structural modifications that occur in these binary systems are closely related to the isomorphous structures that occur in the rare-earth metal series. (auth)

3932 PROTON AND ALPHA-PARTICLE CHANNELING AS A TOOL FOR LOCATING FOREIGN ATOMS IN CRYSTALS. Eriksson, L.; Davies, J. A.; Denhartog, J.; Matzke, H. J.; Whitton, J. L. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. Nucl. Technol., 5: No. 6, 40-3(Nov.-Dec. 1966).

The theoretical principles and the experimental techniques required for basic work in the field of proton and of alpha-particle channeling for locating foreign atoms in crystals are discussed. A few cases where this technique has been used to locate ion-injected foreign atoms in crystals are considered. (W.D.M.)

3933 EFFECT OF ^{60}Co γ RAYS ON HIGH-RESISTIVITY p-TYPE Si. Djèrassi, H.; Merlo-Flores, J.; Messier, J. (Saclay Nuclear Research Center, France). J. Appl. Phys., 37: 4510-16 (Nov. 1966).

Defects created by γ rays in high-resistivity (1,000 to 10,000 Ω-cm) boron-doped silicon were studied by Hall effect and resistivity measurements. Only one energy level is observed at 0.268 eV above the valence band by irradiation at 300°K. Its statistical weight is equal to ½. The defect annealing between 100° and 200°C occurs by the agency of another defect. In some special cases, a more complex association with a third defect can be observed, which introduces another level at 0.21 eV above the valence band. All the results obtained are compatible with the divacancy assumption. Furthermore, the formation, by irradiation at 77°K, of unstable defects that disappear at 170°K was observed. (auth)

3934 IRRADIATION OF HEUSLER ALLOYS. Papadimitraki-Chlichlia, H.; Blaise, A. (CEN, Grenoble, France). J. Phys. (Paris), 27: 463-8(July-Aug. 1966). (In French).

Some Heusler alloys of the type $(Cu_2MnAl)_x$ and $(Cu_3Al)_{1-x}$(x = 0.4 and 0.5) showing superparamagnetic properties, are studied by magnetic measurements. Variation of the size distribution of the magnetic precipitates is observed after low-temperature neutron irradiation: the total volume of the precipitates decreases with a logarithmic law versus the integrated fast neutron flux. From this law, a number of displaced atoms per neutron collision is deduced and compared to the number found in irradiating alloys showing order–disorder transitions. (auth)

3935 EXCITED LEVEL OF THE M CENTER IN THE F BAND IN LiF. Dubois, Monique; Berge, Pierre; Blanc, Georges; Adam-Benveniste, Mireille (Service de Documentation du Centre de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. B, 263: 771-4(Sept. 26, 1966). (In French).

Very pure single crystals of LiF were irradiated with a ^{60}Co source for doses from 1.6×10^5 to 1.12×10^6 R and the excitation and emission spectra were measured. A weak fluorescence was detected in the F band which seemed to be connected with the M center and which could correspond to an excited level higher than M. (G.O.Y.)

3936 THEORY OF NUCLEAR SPIN POLARIZATION INDUCED BY HOT ELECTRONS. Zvezdin, A. K. Zh. Eksp. Teor. Fiz., 51: 819-24(Sept. 1966). (In Russian).

Nuclear spin polarization due to hot electrons (Feher effect) is studied theoretically for the case when the electron distribution function differs from the Boltzmann or Fermi distributions. The possible shape of the hot electron distribution with respect to spin sublevels is investigated. The dependence of the nuclear polarization on the distribution function parameters is elucidated. (auth)

3937 CRYSTAL STRUCTURE OF DYSPROSIUM AT 77 TO 300 DEGREE K. Finkel, V. A.; Vorobev, V. V. Zh. Eksp. Teor. Fiz., 51: 786-90(Sept. 1966). (In Russian).

The crystal structure of dysprosium is studied by the low-temperature x-ray diffraction method at temperatures between 77 and 300°K. It is shown that at 178°K a negative λ anomaly of the thermal expansion coefficients occurs which is related to a phase transition of the second kind similar to the helicoidal antiferromagnetism–paramagnetism type of transition. A discontinuity in the crystal lattice period and atomic volume at 85°K and also the appearance of rhombic distortions of the hexagonal lattice related to an antiferromagnetism–ferromagnetism phase transition of the first kind are observed. (auth)

3938 PHYSICS OF SOLIDS AT HIGH PRESSURES. Proceedings of the First International Conference held in Tucson, Arizona, April 20–23, 1965. Tomizuka, C. T.; Emrick, R. M. (eds.). New York, Academic Press, 1965. 614p. $14.50. (CONF-650423).

Papers are included on: electronic properties of metals, semiconductors, and molecular crystals; ferromagnetism in metals and alloys; and lattice defects and phase transformations and transitions in crystalline solids. (M.H.R.)

Theoretical Physics

Refer also to abstracts 3350, 3598, 3660, and 4038.

3939 (RISO–127) DIAGONALIZATION PROCEDURE FOR A BOSE-SYSTEM HAMILTONIAN. Kowalska, Antonina (Jagellonian Univ., Krakow (Poland). Inst. of Physics); Mogensen, P. A. Lindgard (Danish Atomic Energy Commission, Risoe. Research Establishment). May 1966. 30p. Dep. mn.

A diagonalization procedure for a quadratic form of Bose operators is presented. Explicit, exact expressions for the eigenvalues and the transformation matrices are given for the case of two interacting Bose systems. Examples of possible applications are: simple magnon treatment of antiferromagnets or ferromagnets with two atoms per unit cell; magnon–phonon interactions; and other interactions between collective modes. (auth)

3940 SPHERICALLY SYMMETRIC SPACE-TIMES AND PETROV'S CLASSIFICATION. Rao, J. Krishna (Sardar Patel Univ., Gujarat, India). Curr. Sci. (India), 35: 589(Dec. 5, 1966).

It is shown that the Weyl conformal curvature tensor of the most generally symmetric space-time is of type D. (W.D.M.)

3941 SPACE–TIME METRICS AND NONLINEAR FIELDS. Blokhintsev, D. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Dokl. Akad. Nauk SSSR, 168: 774-6(June 1, 1966). (In Russian).

Certain requirements for signal linearity implicitly contained in the special theory of relativity are usually ignored. Einstein has

noted many times that we must deal with the sum "geometry plus physics," not with each component individually. This "sum" is analyzed in the example of an abstract world in which there is only one form of matter: the scalar field (X) distributed in space R(X) ($X = X_1, X_2, X_3, X_4$). In this case the directions in space $R_4(X)$ are divided into time directions (within the zone of influence) and space directions (without it). In order to differentiate between space and time, it is necessary to employ a signal which has a cone of influence including all other possible cones of influence. It is noted that the Klein equation, as usually applied, leads to particle motion with speeds higher than the velocity of light. From the point of view of the definition of time given (area attainable by a signal), it is considered that there is one space coordinate and three time coordinates: X_1, X_2, X_3. With this definition of time, particle velocities described by the Klein equation will be less than the velocity of light. (JPRS)

3942 MARX'S VARIATIONAL PRINCIPLE. Dolan, P. (Imperial Coll. of Science and Tech., London). Acta Phys. Pol., 30: 617-28(Oct. 1966).

The matter tensor of a generally relativistic perfect fluid is derived from an invariant integral by a method of Marx and a condition on the Ricci scalar R gives Einstein's material equations. A reasonable physical interpretation can be given to the form of the matter tensor which is found. (auth)

3943 WAVE MECHANICS IN CLASSICAL PHASE SPACE, BROWNIAN MOTION, AND QUANTUM THEORY. Della Riccia, Giacomo (Indiana Univ., Bloomington); Wiener, Norbert. Contract NSF-GP-149. J. Math. Phys. (N. Y.), 7: 1372-83(Aug. 1966).

A wave dynamics of fields $\varphi(p,q;t) \in L_2(\Gamma)$ over the phase space $\Gamma(p,q)$ of a classical system S is derived from the Liouville theorem. The energy contained in a given field $\varphi(p,q;t)$ is defined. It is shown that for a special class of fields, selected on physical grounds, the energy spectrum is given by a time-independent Schrödinger equation. This allows one to associate with S an ordinary quantum system Q such that the values of the quantized energy coincide for the fields in the phase space of S and for Q. Use is made of Wiener's stochastic integral based on the theory of Brownian motion to derive probabilities which are the same as those one would obtain through Born's statistical postulate of quantum theory. From this it follows that normalized fields $\varphi(p,q;t)$ can be regarded as "probability amplitudes" leading to a probability density function $\rho(p,q;t) = \varphi\varphi^*$ in the sense of Gibbs' statistical mechanics. The work therefore appears as a bridge between a statistical theory (in the sense of Gibbs) of a mechanical system S and the usual quantum theory of the related quantum system Q. (auth)

3944 A CORRESPONDENCE BETWEEN THE DIRAC THEORY AND CLASSICAL THEORIES FOR PARTICLES WITH SPIN. Plahte, E. (Agricultural Coll. of Norway, Vollebekk). Nuovo Cimento, Suppl. (1), 4: 291-300(1966).

An interpretation of certain classical theories of particles with spin is attempted. As a result of this interpretation, a classically established set of equations is obtained, corresponding to the other set of equations for spin-½ particles deduced earlier (Nuovo Cimento, Suppl. 4: 246(1966)). A comparison with the semiclassical limit of the Dirac theory as presented in the earlier paper is carried out and discussed. (W.D.M.)

3945 CONSTRUCTION OF VANISHING CYCLES FOR INTEGRALS OVER HYPERSPHERES. Boyling, J. B. (Brandeis Univ., Waltham, Mass.). J. Math. Phys. (N. Y.), 7: 1749-63 (Oct. 1966).

The homological methods of Fotiadi et al. are applied to the study of the analytic properties of an integral over an l sphere Γ of a closed meromorphic l form on the complex quadric of which Γ is the real section. Vanishing cycles are explicitly constructed at points of a certain standard type, and the relevant Kronecker indices are evaluated. The Picard–Lefschetz theorem and the decomposition theorem are then applied to obtain linear relations between the discontinuities round various singularities. The results have a direct physical interpretation in the cases $l = 4$ and $l = 2$ in terms of the Riemann sheet structure of single-loop Feynman diagrams with four, five, or six vertices. They give linear relations between the various discontinuity functions, which generalize the results obtained by Fotiadi and Pham for the two-particle discontinuity of the five-point loop and for the complete Feynman amplitude of the four-point loop. (auth)

3946 ON THE NATURE OF THE CENTRAL BODY IN THE SCHWARZSCHILD SOLUTION. Gertsenshtein, M. E. (Inst. of Physics, Tech. and Radiochemical Research, USSR). Zh. Eksp. Teoret. Fiz., 51: 1127-34(Oct. 1966). (In Russian).

The condition $ds^2 \geq 0$ for matter of a central body results in an oscillatory motion irrespective of the equation of state, spherical symmetry being assumed. The motion of dust-like matter with zero pressure is considered. In the nonrelativistic case the motion is oscillatory and on transition from compression to expansion the particles pass through the center. It is demonstrated that the oscillatory nature of the motion also remains in the relativistic case if quantum effects at the singularity are not taken into account; the maximal radius r_{max} must exceed the gravitational radius r_g. The possibility of observation of the oscillatory motion by an external observer is discussed. For a pulsating solution the boundaries of the R and T regions is not fixed and does not pass through vacuum ($g_{00} \neq -g_{11}^{-1}$). Therefore the time (t) integral for a light ray to reach the R–T boundary converges, $t < \infty$; thus the central body can be observed from the R region and energy emission is not forbidden. When energy is emitted $r_{max} \to r_g$ and the emission time can exceed the characteristic time r_{max}/c by several orders of magnitude. (auth)

3947 COHERENCE PROPERTIES OF TWO-PHOTON SYSTEMS. Menegozzi, L. (Balseiro Instituto de Fisica, Comision Nacional de Energia Atomica, Bariloche, Argentina). Nuovo Cimento, Suppl. (1), 4: 15-36(1966).

A description of single photons by associated classical fields and their intrinsic limitations are given. This concept is found useful, in view of the space–time image it provides, to describe in an intuitive way the physical situation, when the coherence properties of two different photons are dealt with. Two cases of weakly and strongly correlated photons are examined: the emission of photons by two excited, distant atoms and the two-photon packet emitted by the doubly excited harmonic oscillator. The developments are examined from the point of view of the methods of correlation functions, proposed by others for the description of coherence. (W.D.M.)

3948 UNIQUE CANONICAL REPRESENTATION OF THE INHOMOGENEOUS LORENTZ GROUP IN RELATIVISTIC PARTICLE DYNAMICS. Hill, Robert Nyden; Kerner, Edward H. (Univ. of Delaware, Newark). Phys. Rev. Lett., 17: 1156-8 (Nov. 28, 1966).

The Lie–Königs theorem was sharpened to consider the question of the canonical representation of symmetry groups of even-order differential equations. An application to instantaneous action-at-a-distance relativistic mechanics yields the existence and uniqueness of a hamiltonian formulation within the framework of the canonical representations of the Lorentz group. (auth)

3949 EQUATIONS OF THE DE BROGLIE WAVE FIELD IN SPACE–TIME. Kulhanek, J. Nuovo Cimento, Suppl. (1), 4: 172-84(1966).

A description is given of de Broglie waves in relativistic dynamics. The energy tensor of the de Broglie wave field in space–time and the equations of the de Broglie wave field are derived. Characteristics and velocity of de Broglie waves in space–time are considered. (W.D.M.)

3950 A SOLVABLE N-BODY PROBLEM. Brezin, Edouard; Zinn-Justin, Jean (CEN de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. B, 263: 671-3(Sept. 12, 1966). (In French).

It was previously stated by J. B. McGuire (J. Math Phys., 5: 622(1964)) that the N-body problem having potentials $\delta(x_i - x_j)$ is exactly solvable. A simple demonstration of this fact is given, and it is shown how this leads directly to a practical method for calculating the solutions. (tr auth)

3951 INTERPRETATION OF THE HAMILTONIAN OPERATOR H_{op} AND THE OPERATOR SQUARE OF THE ANGULAR MOMENTUM M^2_{op} IN QUANTUM MECHANICS. de Broglie, Louis; Andrade e Silva, Joao. Compt. Rend., Ser. B, 263: 645-8 (Sept. 5, 1966). (In French).

The theory of the double solution of the H_{op} and M^2_{op} operators in quantum mechanics is interpreted as a Newtonian degeneracy of corpuscular dynamics with variable mass. (tr-auth)

3952 DO THE COMMUTATION RULES FOR COUPLED FIELDS DEPEND ON THEIR INTERACTION? Masperi, L. (Cuyo National Univ., Mendoga, Argentina. Comision Nacional de Energia Atomica, Bariloche, Argentina). Nuovo Cimento, Suppl. (1), 4: 1-14(1966).

A quantum treatment for the propagation of electromagnetic waves in a plasma of oscillators is developed, which in some features is different from the existing method, though not in the final result. The treatment follows closely the usual classical method. The treatment of the problem by Hopfield is compared with the one presented here. The equivalence and connection of the two methods are shown. (W.D.M.)

3953 SET OF EXACTLY SOLVABLE POTENTIALS. Luming, M.; Predazzi, E. (Univ. of Chicago). Contract AT (11-1)-264. Nuovo Cimento (10), 44B: 210-12(July 11, 1966). (COO-264-311; EFINS-66-24).

A set of potentials is described for which the Schrödinger equation can be solved exactly. This is the set containing all the potentials that give rise to Schrödinger equations which are invariant under the same O_4 group as that for the Coulomb potential (with negative bound-state energy). (M.O.W.)

3954 QUANTIZATION IN THE GENERAL THEORY OF RELATIVITY BY MEANS OF INTEGRALS IN CURVED FUNCTIONAL SPACE. Burlankov, D. E. (Gorkii State Univ., USSR). Zh. Eksp. Teor. Fiz., 51: 842-53(Sept. 1966). (In Russian).

The "all history integral" formalism is applied for quantization of the gravitational field. It is demonstrated that the functional space of all possible time-spaces possesses a curvature as a result of which transition to operators and the dynamical theory is found to be impossible. The quantum theory of a weak gravitational field is a theory based on functional space tangent to the curved space. Exclusion of interaction of the gravitational field with other matter leads to the classically defined metric and as a result the S matrix formalism turns out to be applicable. On quantization of the gravitational field the quantum theory of all other fields is necessarily of the S matrix type. (auth)

3955 PRECESSION OF SATELLITE ORBITS IN GENERAL RELATIVITY. II. Goldberg, I.; Marx, E. (Clarkson Coll. of Tech., Potsdam, N. Y.). Nuovo Cimento (10), 44B: 91-4(July 11, 1966).

Experimental verification of the general theory of relativity by means of satellites is discussed. An improved set of orbits which maximize the astronomical "figure of merit" for pericenter precession is presented. A critique of the figure of merit shows that it is possible to further increase the observable effect. (auth)

3956 SINGULAR HYPERSURFACES AND THIN SHELLS IN GENERAL RELATIVITY. Israel, W. (Univ. of Alberta, Edmonton). Nuovo Cimento (10), 44B: 1-14(July 11, 1966).

An approach to shock waves, boundary surfaces and thin shells in general relativity is developed in which their histories are characterized in a purely geometrical way by the extrinsic curvatures of their embeddings in space-time. There is some gain in simplicity and ease of application over previous treatments in that no mention of "admissible" or, indeed, any space-time co-ordinates is needed. The formalism is applied to a study of the dynamics of thin shells of dust. (auth)

3957 PRODUCT OF TWO SURFACES IN GENERAL RELATIVITY. Singh, K. P.; Sharan, R. (Banaras Hindu Univ., India). Proc. Nat. Inst. Sci. India, Pt. A, 31: 584-92(Nov. 1965).

A Riemannian fourfold of class two representing the product of two surfaces is considered. The corresponding space-time does not admit the possibility for perfect fluid distribution, and the empty space-time conditions, $R_{ij} = 0$, lead to flat space-time. Such material distribution is possible as would admit the eigenvalues $(\lambda, \lambda, \sigma, \sigma)$. Necessary conditions in scalar form are obtained so that a Riemannian fourfold may be decomposable into a product of two surfaces. A necessary and sufficient condition for the product of two surfaces to represent a non-null electromagnetic field is that the resulting Riemannian fourfold be conformal to flat. In this case the behavior of the field with regard to gravitational radiation according to Petrov-Pirani classification becomes indeterminate. The conditions for null electromagnetic field lead to flat space-time. A scalar condition which is necessary and sufficient that the product space be flat is obtained in terms of the projective curvature invariant. There are three divergences associated with the projective curvature tensor W_{hijk}. All the three divergences vanish separately in an Einstein space. A necessary and sufficient condition that the two surfaces be of constant Riemannian curvatures is that either of the three divergences of W_{hijk} vanishes. In an electromagnetic field represented by the product space, all the three divergences vanish separately. (auth)

3958 GENERAL THEORY OF RELATIVITY. Trautman, A. (Warsaw Univ.). Usp. Fiz. Nauk, 89: 3-31(May 1966). (In Russian).

A survey is presented of various results and problems of general relativity. Considerable effort was devoted to controversial questions such as the postulate of general covariance, the equivalence principle, preferred coordinate systems, conservation laws, and gravitational radiation. No cosmology or relativistic astrophysics are discussed. The standard papers dealing with the fundamental problems of relativity theory are cited in the concluding remarks. (TSS)

3959 THREE-DIMENSIONAL FORMULATION OF GRAVITATIONAL NULL FIELDS. I. Misra, R. M.; Singh, R. A. (Univ. of Gorakhpur, India). J. Math. Phys. (N. Y.), 7: 1836-40(Oct. 1966).

The four-dimensional normal hyperbolic Riemannian space is represented as a direct product of a three-dimensional space and a timelike line. The null gravitational field is defined in a manner analogous to that of electromagnetic field. It is shown that in this way three types of gravitational null fields can be characterized. They can be designated as gravitational null fields of types A, B, and C. It is found, as necessary and sufficient conditions, that the gravitational field be null field of types A and B, respectively. It is also shown that these null fields admit null vectors in accordance with the properties of gravitational radiation fields. (auth)

3960 SCATTERING CROSS SECTION FOR A BEAM OF WAVE PACKETS. Katz, Amnon (Weizmann Inst. of Science, Rehovoth, Israel). J. Math. Phys. (N. Y.), 7: 1802-5(Oct. 1966).

The scattering cross section is evaluated for a beam of wave packets of almost arbitrary form. It is found that this cross section is the superposition of the cross sections of various plane waves, which make up the wave packet without interference. For wave packets of well-defined momentum, the usual rule that the scattering cross section is the absolute square of the scattering amplitude is regained. (auth)

3961 EXISTENCE OF CLOSED MAGNETIC SURFACES. Faulkner, James E. (Aerojet-General Nucleonics, San Ramon, Calif.). J. Math. Phys. (N. Y.), 7: 1771-5(Oct. 1966).

A toroidal vacuum magnetic field, which has closed magnetic surfaces in the neighborhood of the magnetic axis, is mathematically constructed. The existence of these surfaces is demonstrated by the theorem of Moser on the stability of mappings which are perturbations of rotations whose rotation angle is a function of the radius (twist mapping). (auth)

3962 DERIVATION OF THE SCHROEDINGER-PAULI EQUATION OF THE SPINNING ELECTRON FROM THE RIGID-SPHERE MODEL. Sparzani, A. (Univ., Pavia, Italy. Istituto Nazionale di Fisica Nucleare, Pavia, Italy). Nuovo Cimento, Suppl. (1), 4: 231-45(1966).

The Schroedinger-Pauli equation of the spinning electron is deduced starting from the rigid-sphere model of Uhlenbeck and Goudsmit. A classical Hamiltonian theory of this model is given, then by quantization a theory is obtained which describes the spin through differential operators, and in which all integral and half-odd integral spin eigenvalues are allowed. It is shown that by making use of a suitable expansion of the total wave function and imposing the condition $j = \frac{1}{2}$, the Pauli spin operators and the Schroedinger-Pauli equation can be obtained. Some useful results of the representation theory of the three-dimensional rotation group are given. (W.D.M.)

3963 CLASSICAL EQUATIONS OF MOTION FOR SPIN-1/2 PARTICLES IN EXTERNAL INHOMOGENEOUS ELECTROMAGNETIC FIELDS. Plahte, E. (Agricultural Coll. of Norway, Vollebekk). Nuovo Cimento, Suppl. (1), 4: 246-75(1966).

An attempt is made to obtain a classical description of a quantum-mechanical system. To make the Dirac equation easier to handle, it is first transformed to the so-called semiclassical picture in the limit where $\hbar$ may be considered small. Terms of second order in $\hbar$ are kept in the Hamiltonian, and the treatment is fully relativistic and covariant. A similar transformation of the squared Dirac equation is carried out. The lowest-order semiclassical equations of motion are given and are found to coincide with the spin-momentum equations of the Dirac particle. The classical equations are established and a brief discussion is given. Some useful operator relations are presented and the relation between the linear and squared Dirac equations in the semiclassical picture is shown. (W.D.M.)

3964 USE OF ORTHOGONALIZED PLANE WAVES IN THE MANY-ELECTRON PROBLEM. Girardeau, M. D.; Sage, M. L. (Univ. of Oregon, Eugene). Physica, 32: 1521-42(Sept. 1966).

Mathematical difficulties associated with nonuniqueness of expansion coefficients occur in the formulation of many-electron problems in terms of bound states and orthogonalized plane waves (OPW's), due to the lack of linear independence of the OPW's. These difficulties are exhibited and overcome through use of subsidiary conditions. The formalism takes its simplest form in terms of an appropriate second-quantization representation in an ideal state space. The representation of physical operators in this space is constructed, and it is shown how the problem of satisfying the subsidiary conditions can then be circumvented. A connection with previous work of S. Tani on scattering from a potential with bound states is exhibited. It is shown how approximations made in solution of many-electron problems can be constructed so as to be consistent with the many-electron OPW formalism. (auth)

3965 THREE-BODY COLLISION OPERATOR IN QUANTUM MECHANICS. II. RENORMALIZATION AND QUASIPARTICLES.

Resibois, P. (Univ. Libre, Brussels). Physica, 32: 1473-1502 (Sept. 1966).

The structure of the three-body collision operator that appears in the transport equation of a moderately dense gas is analyzed in detail. Using a binary scattering matrix expansion, it is shown that this three-body operator can be decomposed into three parts: the first one describes a renormalization of the two-body Boltzmann operator; the second corresponds to genuine three-body collisions between free incident particles; the interpretation of the last part is more complicated and takes a simple form only when the two-particle scattering matrix is energy independent: it corresponds then to a description of transport phenomena in terms of quasiparticles, similar to those obtained recently in the weakly coupled case. (auth)

3966 GRAVITATIONAL RADIATION AND RENORMALIZATION OF MASS IN GENERAL RELATIVITY AND IN A LORENTZ-INVARIANT THEORY. Mavrides, S. (Institut Henri Poincare, Paris). Nuovo Cimento (10), 45A: 859-66(Oct. 21, 1966).

The calculation of the radiation term in the case of single poles is carried out in the framework of a Lorentz-invariant theory including gravitational and inertial masses. A comparison with electrodynamics shows the relationship between the roles of the charge and of the gravitational mass in the renormalization formulas. The radiation terms are similar to those which were obtained in general relativity with the fast approximation method. But the disagreement with the experiment and the consequences of the fast approximation method are avoided in this Lorentz-invariant theory. (auth)

3967 INTEGRAL FORM OF THE EINSTEIN EQUATIONS AND A COVARIANT FORMULATION OF THE MACH PRINCIPLE. Altshuler, B. L. Zh. Eksp. Teoret. Fiz., 51: 1143-50(Oct. 1966). (In Russian).

A method is proposed for writing down the Einstein equations in an integral form by means of a covariant Green function which is a two-point tensor. The difficulties arising from nonlinearity of the Einstein equations can thus be overcome in a natural manner. For a certain choice of the equation for the Green function the integral form appears to be a covariant expression of the Mach principle which now becomes equivalent to the requirement that the Einstein equations be valid in the integral rather than differential form. A number of examples are considered. It is shown, in particular, that the Friedman model of a homogeneous and isotropic universe is not consistent with the Mach principle due to the characteristic behavior of the metric near the singularity in this model. (auth)

3968 DEFINITION OF STATES IN QUANTUM STATISTICAL MECHANICS. Emch, Gerard G. (Univ. of Maryland, College Park). Contract NONR 595(22). J. Math. Phys. (N. Y.), 7: 1413-20(Aug. 1966).

The controversy relative to the use of normal states in quantum physics is discussed in the light of ergodic theory. The nature of the spectrum of the Hamiltonian is shown to play a central role in the decision to enlarge the ordinary frame provided by the traditional density-matrix formalism. The connection of these considerations with the infinite-time, infinite-volume limits in nonequilibrium statistical mechanics is pointed out. (auth)

3969 THEORY OF MULTIPHOTON TRANSITION PROBABILITIES. Kielich, Stanislaw (Mickiewicz Univ., Poznan, Poland). Acta Phys. Pol., 30: 393-414(Sept. 1966).

The formal quantal theory of first-, second-, and higher-order radiation processes inherent in electric and magnetic multipole transitions is developed. The calculated probabilities of two-or more-photon processes consist not only of indirect multipole transitions from initial to final states via one or more successive virtual states, but also of a direct multipole transition related to the second- or higher-order time-dependent interaction Hamiltonian. The general results are discussed in some special cases of electric or magnetic dipolar, quadrupolar, etc. transitions. Tensors of electric and magnetic multipole polarization are derived in the r-th-order approximation of quantal perturbation theory and expressed in terms of r-th-order multipole susceptibility tensors and electromagnetic field strengths in the r-th power. The multipole and nonlinear formalism is given in a compact tensorial notation and can be applied for computing various multiple-photon processes, the investigation of which is liable to provide information on the change undergone by atoms or molecules under the influence of intense electromagnetic fields, e.g., from lasers. (auth)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Electromagnetic

Refer also to abstract 3994.

3970 (NP-16354) UEBERSICHT UEBER DAS EXPERIMENTELLE PROGRAMM UND DIE ERSTEN FORSCHUNGSERGEBNISSE BEIM DEUTSCHEN ELEKTRONEN-SYNCHROTRON. (Review of the Experimental Program and the First Research Results with the German Electron Synchrotron). Meyer-Berkhout, U. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Mar. 20, 1966. 46p. Dep. mn.

A review is given of the experimental program of DESY during the years 1965 and 1966. Some of the research results obtained on photoproduction experiments, electron scattering experiments, experiments on the testing of the validity limits of quantum electrodynamics, and special studies falling in none of the other classes are discussed. Preliminary results were reported on photoproduction processes in a H_2 or D_2 bubble chamber in the photon energy range between 0.3 and 5.8 GeV, photoproduction of dipions and electroproduction of pions, single photoproduction of π^0 and η^0 mesons under forward angles, single photoproduction of π^+ and K^+ mesons at small angles, photoproduction of antiprotons, elastic and inelastic e-p and e-d scattering, systematic search for the production of a heavy electron in e-p collisions, quasielectric e-d scattering, wide-angle electron-positron pair production by photons, investigation of bremsstrahlung intensity spectra using a pair spectrometer, production of coherent bremsstrahlung by irradiation of a diamond crystal with fast electrons, and experiments with the synchrotron radiation in vacuum in the uv and x range up to 300 keV. (J.S.R.)

3971 (NYO-2171-210) THEORETICAL AND EXPERIMENTAL RESEARCH ACTIVITIES IN HIGH ENERGY PHYSICS. Progress Report, September 1965–September 1966. (Pennsylvania Univ., Philadelphia. Dept. of Physics). Oct. 1, 1966. Contract AT(30-1)-2171. 54p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The theoretical and experimental research activity of the Univ. of Pennsylvania in elementary particle physics from Sept. 1965 thru Sept. 1966 is reported. Topics discussed are nuclear structure, pion-nucleon scattering, symmetry groups, current commutator algebra, experiments with the Princeton-Pennsylvania Accelerator, bubble chamber analysis program, and experimental support activities. (B.G.D.)

3972 IONIZATION LOSS OF ELECTRONS AT HIGH ENERGIES. Kushwaha, U. S. (Panjab Univ., Chandigarh, India). pp 664-9 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

The behavior of ionization loss of electrons in the energy region $\gamma \approx 100$ to 5000 was investigated using Ilford G-5 emulsions. The results are consistent with the existence of a flat plateau in accordance with the Sternheimer's ionization loss theory, though the possibility of a slight increase in ionization loss around $\gamma \approx 200$ is not ruled out. (auth)

3973 ELASTIC ELECTRON–PROTON SCATTERING AT MOMENTUM TRANSFERS UP TO 245 F^{-2}. Albrecht, W.; Behrend, H. J.; Brasse, F. W.; Flauger, W.; Hultschig, H.; Steffen, K. G. (Deutsches Elektronen Synchrotron, Hamburg). Phys. Rev. Lett., 17: 1192-5(Dec. 5, 1966).

Measurements of elastic electron–proton scattering were performed up to $q^2 = 245\ F^{-2}$. Electrons were detected at momentum transfers between 100 and 245 F^{-2} and scattering angles of approximately 47 or 75°. Since in this region magnetic scattering is largely dominant, the magnetic form factor was deduced from a single cross section measurement. The cross sections and form factors obtained by measuring scattered electrons and recoil protons are listed. (J.F.P.)

3974 η PHOTOPRODUCTION CROSS SECTION FOR INCIDENT PHOTON ENERGIES FROM 800 TO 1000 MeV. Bacci, C. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome); Penso, G.; Salvini, G.; Mencuccini, C.; Silvestrini, V. Nuovo Cimento (10), 45A: 983-1009(Oct. 21, 1966).

Photoproduction cross section of the η-particle for incident photon energies K from ~800 to ~1000 MeV was measured at the 1.1 GeV Frascati electronsynchrotron. The differential cross section for this process, at a c.m. angle of the η of ~110°, turns out to be fairly constant for 830 MeV ≤ K ≤ 900 MeV, and drops down by a factor 5 to 10 at K = 950 MeV. These results are discussed in terms of a comparison with the data on the production of η's by pions, and with the data on pion-nucleon scattering and pion photoproduction. The conclusions are in agreement with the hypothesis that the η-N system is dominated at low energies by a resonance with orbital angular momentum l = 0 ($S_{1/2}$ resonance). (auth)

Weak

Refer also to abstract 3970.

3975 (JINR-P-2892) ZARYADOVOE OTNOSHENIE V K^0_{e3}-RASPADE. (Branching Ratio in K^0_{e3}-Decay). Mestvirishvili, A. N.; Nyagu, D.; Petrov, N. I.; Rusakov, V. A.; Wu, Tzun-fan (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1966. 5p. (In Russian). Dep. mn.

On the basis of the identification of 866 K^0_{e3} and 28 $K^0_{\mu 3}$ decays the branching ratio is found to be $R = N(K^0_2 \to \pi^+ + e^-(\mu^-) + 0)/N(K^0_2 \to \pi^- + e^+(\mu^+) + 0) = 1.04 \pm 0.07$. (auth)

3976 (JINR-P1-2948) OBNARUZHENIE RASPADA $\pi^0 + \gamma\omega^0$-MEZONOV, ROZHDENNYKH π^--MEZONAMI S IMPUL'SOM 9 GeV/c V π^--Xe VZAIMODEISTVIYAKH. (Detection of the $\pi^0 + \gamma$-Decay of ω^0-Mesons Produced by π^--Mesons With the 9 GeV/c Momentum in π^--Xe Interactions). Kanarek, T. I.; Loskevich, E.; Martynov, A. S.; Nichiporuk, B.; Semashko, G. L.; Semyarchuk, T.; Strugal'skii, Z. S.; Eskreis, K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1966. 17p. (In Russian). Dep. mn.

With the help of a 24-liter xenon bubble chamber exposed in the π^- meson beam with the 9 GeV/c momentum the search was performed for radiative decay of neutral bosons, decaying finally into 3 γ-quanta. The $\omega^0 \to \pi^0 + \gamma$ decay was detected directly by the presence of the peak determined from statistics in the effective mass distribution $m_\pi 0_\gamma$. The upper limit of the ratio of probabilities of two possible channels of ω^0-decay is: $R = W(\omega^0 \to \gamma + \gamma + \gamma)/W(\omega^0 \to \pi^0 + \gamma) \leq 0.2 \pm 0.15$. The lower limit for the total cross section of ω^0 production in π^-–Xe interaction is estimated to be $\sigma_{Xe}(\omega^0) > 7.1 \pm 1.5$ mb. (auth)

Strong (Baryon-Induced)

3977 (JINR-E1-2952) SPECIFICATION OF THE N-N PHASE SHIFT ANALYSIS AT 23.1 MeV. Kazarinov, Yu. M.; Legar, F.; Yanout, Z. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1966. 7p. Dep. mn.

The N-N phase shift analysis at 23.1 MeV was specified on the basis of new experimental data on the measurement of C^{np}_{nn} parameter and P_{np} polarization at the angle 140° (cms). It is shown that the addition of new data within the errors does not change the solution found previously. (auth)

3978 (JINR-E1-2969) PHASE-SHIFT ANALYSIS AND PLANNING OF EXPERIMENTS AT 18.2 AND 9.7 MeV. Kazarinov, Yu. M.; Legar, F.; Ulegla, I.; Yanout, Z. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1966. 24p. Dep. mn.

The simultaneous phase-shift analysis of np and pp data is performed at 18.2 and 9.7 MeV. Three and four sets of phase-shifts are obtained, respectively. Previously obtained nuclear potentials for nonmixing states of two-nucleon system are used to calculate the maximum error in the simultaneous phase-shift analysis, due to the assumption on the additivity of the Coulomb and nuclear phase-shifts. Optimal experiments are planned for a further specification of the phase-shift analysis. The angular distributions of the experimental quantities are given on graphs. (auth)

3979 ANALYSIS OF 4.4 GeV/c PION AND 6.2 GeV/c PROTON INTERACTIONS IN EMULSION NUCLEI ON ISOBAR MODEL. Dubey, D. P.; Kushwaha, U. S.; Singh, M. B.; Swami, M. S. (Panjab Univ., Chandigarh, India). pp 605-10 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

Some features of interactions of 4.4-GeV/c pions and 6.2-GeV/c protons with nucleons of emulsion nuclei were analyzed in light of the isobar model. (auth)

3980 ANALYSIS OF SMALL SIZE STARS ($N_h \leq 4$) IN PHOTOGRAPHIC EMULSIONS, EXPOSED TO BEAMS OF 24 AND 27

GeV/c PROTONS. Rao, G. K.; Rao, P. D. K.; Kamal, A. A. (Osmania Univ., Hyderabad, India). pp 611-18 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

An analysis of small-size stars ($N_h \leq 4$) is presented from a total of 1386 events. The target-mass distribution for stars with $N_s > 2$ is given, and an energy estimate is made using the formulas of Castagnoli et al. and Yajima and Hasegawa. (J.F.P.)

3981 SOME FEATURES OF PROTON–NUCLEON INTERACTIONS AT 23 GeV. Bhowmik, B.; Shivpuri, R. K. (Univ. of Delhi). pp 619-28 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

Some features of 22.8-GeV proton interactions with nucleons in emulsion were investigated. From a total of 738 interactions obtained by following 276 meters of proton track length, 94 events were classified as proton–nucleon interactions. The average values of transverse momentum ($\langle p_t \rangle$) for secondary protons and pions were found to be (435 ± 35) MeV/c and (332 ± 35) MeV/c respectively. The p_t distribution of protons and pions were found to be in agreement with the expressions $dN \alpha p_t^2 \times e^{-P_t/155} dp_t$ and $dN \alpha p_t \times e^{-P_t/155} dp_t$ respectively. It is observed that for angles less than 25° $\langle p_t \rangle$ increases with the angle of emission in the lab. system. Monte Carlo calculations were done for the center-of-mass momentum distributions of final-state protons and pions assuming them to be the decay products of excited baryon states. A two-body decay and isotropic distribution of the emitted particles were assumed for the decaying isobars. It is observed that the predictions of statistical theory and isobar model calculations for the center-of-mass momentum distribution of pions are not different, whereas for nucleons they are widely separated. The experimental center-of-mass momentum distribution for protons beyond 1.6 GeV/c can be analyzed from isobar model calculations. (auth)

3982 ON NEUTRAL BARYONS FROM 24 GeV PROTON INTERACTIONS IN CARBON. Bhalla, K. B.; Jha, S. K.; Aditya, P. K.; Lokanathan, S. (Indian Inst. of Tech., Delhi). pp 629-31 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

Stars due to neutral baryons produced by 24-GeV proton interactions with carbon nuclei were analyzed to estimate the energy of the neutral baryons and to study the variation of energy with multiplicity of these stars. Also the average number of neutral baryons within an energy range of 4 to 6 GeV, produced per 24-GeV proton–carbon nucleus interaction was estimated. (auth)

3983 ON THE ENERGY OF CHARGED BARYONS FROM 27 GeV PROTON INTERACTIONS IN EMULSIONS. Aditya, P. K. (Indian Inst. of Tech., Delhi). pp 632-7 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

Singly charged relativistic particles coming out of 27-GeV proton interactions and emerging in precisely the same direction as the primary were followed up to the point of interaction. For some the energy was determined by the multiple scattering. It was found that, on the average, the surviving baryon retains about one-third of the primary energy. (auth)

3984 EXPERIMENTAL ASPECTS OF THE USE OF CARBON–HYDROGEN POLARIZED PROTON TARGETS. Cahill, Th. A. (Univ. of California, Los Angeles). Nucl. Instrum. Methods, 42: 327-8(July 1966).

The experimental aspects of the use of carbon-hydrogen polarized proton targets for proton-proton scattering experiments in the medium energy region are discussed. Comparisons are made to standard double nitrate polarized proton targets, based on $La_2Mg_3(NO_3)_{12} \cdot 24H_2O$. (B.G.D.)

3985 ANTIPROTON–PROTON ELASTIC AND INELASTIC TOTAL CROSS-SECTIONS BETWEEN 57 AND 178 MeV. Amaldi, U. Jr. (CERN, Geneva); Conforto, B.; Fidecaro, G.; (and others). Nuovo Cimento (10), 46A: 171-88(Nov. 1, 1966).

About 25000 interactions of antiprotons of kinetic energy between 57 and 178 MeV were measured in a hydrogen bubble chamber. Elastic and inelastic total cross sections were determined at 15 values of the antiproton energy. The results are compared with theoretical predictions. (auth)

3986 DETECTION OF QUARKS IN THE ULTRAVIOLET SOLAR SPECTRUM. Bennett, W. R. Jr. (Yale Univ., New Haven). Contract CST-103. Phys. Rev. Lett., 17: 1196-8 (Dec. 5, 1966).

It is found that all of the weak, unidentified solar lines reported by Sinanoğlu, Skutnik, and Tousey in the vicinity of calculated "quark" transitions may be explained by weak electric-dipole transitions expected in the normal species. Avoidance of ambiguity through overlap with weak transitions of the normal species appears to require identification to better than ≈ 0.04 Å in the far-ultraviolet solar spectrum. (auth)

3987 AN UPPER LIMIT TO THE ELECTRIC DIPOLE MOMENT OF THE Λ^0. Gibson, W. M.; Green, K. (Univ. of Bristol, Eng.). Nuovo Cimento (10), 45A: 882-4(Oct. 21, 1966).

An experimental upper limit of $5.0 \cdot 10^{-14}$ cm × e was set for the electric dipole moment of the Λ^0. (auth)

Strong (Meson-Induced)

Refer also to abstract 3979.

3988 (UCRL–17153) MEASUREMENT OF POLARIZATION PARAMETER IN NEGATIVE PION PROTON SCATTERING FROM 229 TO 390 MeV. Arens, John Frederic (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1966. Contract W-7405-eng-48. 49p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. Thesis.

The $\pi^- p$ polarization parameter was measured at several energies and angles using a polarized proton target at the 184-in. cyclotron. The data at 229 MeV covered the angles between 150 and 180° in the center-of-mass system; at 318, 337, and 390 MeV the angles between 70 and 180° were included. Scintillation counter hodoscopes were used in coincidence to detect both the pions and recoil protons. A small computer was used on-line to facilitate data handling and storage on magnetic tape. Phase shift analyses using this and other published data were made at the two lowest energies. (auth)

3989 ASSOCIATED PRODUCTION NEAR THRESHOLD. Binford, T. O.; Good, M. L.; Lind, V. G.; Stern, D. (Univ. of Wisconsin, Madison). pp 570-6 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

Cross sections, angular distributions, and polarizations were measured for the reactions $\pi^- + p \rightarrow \Sigma^0 + K^0$ and $\pi^- + p \rightarrow \Lambda^0 + K^0$ at incident meson (π) momenta of 1128, 1235, 1277, and 1326, MeV/c. No evidence is found for violation of the triangle inequality from charge independence. The second reaction seems to be dominated by the 1690- and 2190-MeV resonances in $I = 1/2$. (J.F.P.)

3990 ANALYSIS OF $\pi^- - N$ INTERACTIONS IN PHOTOGRAPHIC EMULSIONS. Rao, Y. V.; Rukmini, B. K.; Kamal, A. A. (Osmania Univ., Hyderabad, India). pp 577-83 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

An analysis is made of meson (π^-)–nucleon interactions at 17.2 GeV/c in photographic emulsions. Angular distributions are given for the events studied, and the details of four clean tridents are tabulated. These observations support the A_1 resonance which is a $\pi^- \rho$ system. (J.F.P.)

3991 ON THE INTERACTION OF 17.2 GeV π^- WITH LIGHT AND HEAVY EMULSION NUCLEI. Kohli, J. M.; Mittra, I. S.; Singh, M. B. (Panjab Univ., Chandigarh, India). pp 584-90 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

There were 257.7 meters of track length scanned, and 631 interactions were picked up. These events were separated into π^-–AgBr and π^-–CNO groups on the assumption that the overall numbers of events belonging to AgBr and CNO nuclei are governed by the geometrical cross sections. The results regarding mean multiplicity and angular distribution support the internuclear cascade model. (auth)

3992 COHERENT PRODUCTION OF PIONS ON EMULSION NUCLEI BY 17.2 GeV PIONS. Dubey, D. P.; Kohli, J. M.; Singh, M. B. (Panjab Univ., Chandigarh, India). pp 591-7 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

Experimental verification of coherent events due to Coulomb and diffraction dissociation of pions was studied. These events satisfy a number of parameters connecting angle and energy characteristics. The mean free path of these events is 65.1 meters. It was found that coherent events due to diffraction dissociation take place on lighter semi-transparent nuclei, whereas those due to Coulomb dissociation take place on heavier nuclei. (auth)

3993 ISOBAR MODEL ANALYSIS OF 8 AND 17 GeV PION NUCLEON INTERACTION IN EMULSION NUCLEI. Dubey, D. P.;

Kohli, J. M.; Kushwaha, U. S.; Singh, M. B.; Swami, M. S. (Panjab Univ., Chandigarh, India). pp 598-604 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

Interactions of 8- and 17-GeV pions with nucleons of emulsion nuclei were analyzed on the basis of the isobar model. The experimental energy distribution of pions and nucleons was compared with the predictions of the model. (auth)

3994 STUDY OF ELECTRON PAIRS IN PHOTOGRAPHIC EMULSIONS. Kamal, A. A.; Padmavati, S. V. (Osmania Univ., Hyderabad, India). pp 647-56 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

From an analysis of 178 electron pairs produced in photographic emulsions, exposed to a 17-GeV/C π^- beam, the distributions of the parameters involving pair energy, opening angle, and partition energy were obtained and good agreement is found with Olsen's theory. The opening-angle method for the energy determination of γ rays was re-examined, in the presence of multiple Coulomb scattering, and its scope was compared with theory. (auth)

3995 FURTHER EVIDENCE FOR THE H MESON. Benson, G.; Marquit, E.; Roe, B.; Sinclair, D.; Vander Velde, J. (Univ. of Michigan, Ann Arbor). Phys. Rev. Lett., 17: 1234-7 (Dec. 12, 1966).

Further evidence for the H meson is presented. The decay angular distributions are found to be consistent with $J^P = 1^+$. (auth)

3996 FORMATION OF RESONANT STATES IN $K^- + p \rightarrow K^- +$ p BETWEEN 0.8 AND 1.2 GeV/c. Gelfand, N. M. (Univ. of Chicago); Harmsen, D.; Levi Setti, R.; Predazzi, E.; Raymund, M.; Doede, J.; Maenner, W. Phys. Rev. Lett., 17: 1224-8(Dec. 12, 1966).

A study of K^-p elastic scattering at 22 momenta between 0.777 and 1.182 GeV/c was made. The formation of Y_1^* (1760) and Y_0^* (1820) was observed. Parameters for these two resonances are found from an analysis of the total and differential elastic cross sections based on a model in which the background is described by diffraction scattering. (J.F.P.)

3997 A LIFETIME MEASUREMENT IN A LOW-MOMENTUM Λ BEAM. Englemann, R. (Univ., Heidelberg); Filthuth, H.; Alexander, G.; Karshon, U.; Shapira, A.; Yekutieli, G. Nuovo Cimento (10), 45A: 1038-41(Oct. 21, 1966).

The result of a Λ^0 lifetime measurement using a low-momentum Λ^0 beam produced in K^-p interactions at rest was found to be $(2.45 \pm .06) \cdot 10^{-10}$ s. (L.B.S.)

3998 K^+p ELASTIC SCATTERING AT 3.5 AND 5.0 GeV/c. De Baere, W. (Laboratoire des Hautes Energies, Brussels); Debaisieux, J.; Dufour, P.; (and others). Nuovo Cimento (10), 45A: 885-94(Oct. 21, 1966).

The elastic scattering of K^+ mesons on protons is studied at 3.5 and 5 GeV/c. The total elastic cross sections are found to be (4.36 ± 0.36) mb and (3.82 ± 0.41) mb respectively. The differential elastic cross sections, which exhibit characteristic diffraction peaks, are fitted by $d\sigma/dt = (d\sigma/dt)_0 e^{\alpha t}$, giving $\alpha = (3.85 \pm 0.12)$ and (4.70 ± 0.21) $(GeV/c)^{-2}$ for the two momenta respectively, with $|t| \gtrsim 0.65$ $(GeV/c)^2$. The results are compared to those at neighboring energies, giving some support to the presence of a real part of the forward scattering amplitude. The diffraction peak shows definite shrinking with increasing momenta. The data are examined in the light of models for high-energy scattering. (auth)

3999 K^-p CHARGE-EXCHANGE SCATTERING AT 3.5 GeV/c. Brody, A. D.; Lyons, L. (Oxford Univ.). Nuovo Cimento (10), 45A: 1027-9(Oct. 21, 1966).

An analysis was made of $K^- + p \rightarrow \overline{K}^0 + n$ interactions from 120,000 photographs taken from the Saclay 81-cm hydrogen bubble chamber exposed to a 3.5 GeV/c K^- beam. The total cross section was found to be (0.40 ± 0.09) mb. Differential cross sections are compared with predictions of the ρ-exchange model with absorption and the Regge-pole model of Phillips and Rarita. (L.B.S.)

4000 ELASTIC π^--p INTERACTION AT 650 MeV IN THE BUBBLE CHAMBER. Femino, S.; Jannelli, S.; Mezzanares, F. (Univ., Messina, Italy). Atti Soc. Peloritana Sci. Fis. Mat. Natur., 10: 589-98(1964). (In Italian).

Elastic scattering at (650 ± 15) MeV in a hydrogen bubble chamber was studied. There were 1946 two prong elastic events and 1204 neutral events found in 104 pictures, and the usual corrections to the experimental data were made. The cross sections $\sigma_{el.} = (17.82 + .52)$ mb and $\sigma_n = (11.36 + .41)$ mb were deduced and compared to other results. The differential cross section was deduced from the experimental cm angular distribution. The expansion of the same distribution in a sum of Legendre polynomial is presented. The conclusion is that higher azimuthal states are present until the F-state at least. The differential laboratory cross sections calculated, are: $[d\sigma(0^0)/d\Omega] = (19.65 \pm 1.61)$ mb sr^{-1} and $[d\sigma(180^0)/d\Omega] = (.15 \pm .03)$ $mbsr^{-1}$. (auth

Particle Interactions and Properties (Theoretical)

General

Refer also to abstracts 3724 and 3971.

4001 (CALT-68-101) CURRENT TOPICS IN PARTICLE PHYSICS. Gell-Mann, Murray (California Inst. of Tech., Pasadena). Aug. 31, 1966. Contract AT(11-1)-68. 31p. (CONF-660808-21). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 13th International Conference on High Energy Physics, Berkeley, Calif.

A brief summary is presented on the current topics of elementary particle physics. Included are Regge pole and optical model analysis of high energy scattering, bound and resonant states of mesons and baryons, the quark model, current algebra, and CP violation. (B.G.D.)

4002 (CALT-68-102) CURRENT ALGEBRA. Gell-Mann, Murray (California Inst. of Tech., Pasadena). Oct. 1966. Contract AT(11-1)-68. 33p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A review of some of the main ideas of the algebra of currents is presented. These are: isotopic spin operators, the SU(3) group, axial currents, chiral SU(3) $\otimes$ SU(3), commutation relations, and quarks. Other topics discussed are the Lorentz frame when the momenta are zero near infinity, extension of chiral SU(3) $\otimes$ SU(3) algebra and representation of U(3) $\otimes$ U(3) algebra. (B.G.D.)

4003 (INP-494/PL/PH) PROCEEDINGS OF THE VI CRACOW SCHOOL OF THEORETICAL PHYSICS. (Institute of Nuclear Physics, Krakow (Poland)). Sept. 1966. 240p. Dep.

Topics discussed in low and high energy physics are: the peripheral model with absorption; crossing relations; coherent interactions; SL(2,C) group; hyperfragments; theory of $_\Lambda H^3$; pion-proton interactions; muon capture; quantum electrodynamics; current algebras; scattering theory; origin of resonances A_1, $K^{**}(1320)$, and B(1220); and weak interactions of nucleons in the nucleus. (B.G.D.)

4004 PARTICLE PHYSICS: A SURVEY. Udgaonkar, B. M. (Tata Inst. of Fundamental Research, Bombay). pp 440-58 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

A review of some interesting developments in particle physics is given. The topics covered are the decay of the long-lived K^0 with the implication that CP is not conserved, the increase in particles, resonances, and bumps in cross sections, higher symmetries, bootstrap theory, and Regge pole phenomenology. (J.F.P.)

4005 CONSTRUCTION OF A REPRESENTATION FOR SPIN-2 BARGMANN-WIGNER FUNCTIONS THROUGH TWO SPIN-1 BARGMANN-WIGNER FUNCTIONS. c-NUMBER THEORY. Gallardo, Juan Carlos; Kalnay, Andres Jose; Risemberg, Salomon Hector (Univ. Nacional de Cordoba, Argentina). Progr. Theoret. Phys. (Kyoto), 36: 627-35(Sept. 1966).

A representation for spin-1 Bargmann-Wigner functions in terms of two Dirac functions was given previously. The basic elements of the Bargmann-Wigner formalism which will be needed for the construction of a similar representation are introduced. A representation for spin-2 Bargmann-Wigner functions is obtained. (auth)

4006 APPLICATION OF TRANSVERSITY AMPLITUDES TO THE KINEMATICAL ANALYSIS OF TWO-BODY PROCESSES AT HIGH ENERGIES. Kotanski, A. (Jagellonian Univ., Krakow). Acta Phys. Pol., 30: 629-45(Oct. 1966).

The transversity amplitudes (in which the normal to the scattering plane is chosen as the spin quantization axis) are applied to the analysis of the two-body processes at high energies. This leads to the following simplifications: the crossing relations are simple (the crossing matrix has only one nonzero element in each row and in each column; thus there is no summation in the crossing relations), parity conservation implies vanishing of some transversity amplitudes that is especially convenient in evaluation of spin density matrices of produced resonances in terms of scattering amplitudes, Lorentz transformations in the scattering plane can change at most a phase of the amplitude (and, consequently, of the spin density matrix of a produced resonance). The angular distributions

of the decay products referred to the normal to the scattering plane are explicitly evaluated for several most frequent types of decays. The transversity amplitudes can be expressed in terms of helicity amplitudes; a simple algorithm is given. (auth)

4007 ONE-PARTICLE PAULI MASTER EQUATION FOR INDIRECT INTERACTIONS. Fulinski, A. (Jagellonian Univ., Krakow). Acta Phys. Pol., 30: 671-81(Oct. 1966).

The interactions between a system of particles (bosons or fermions) and a boson field, described by the (nonrelativistic) hamiltonian of the Fröhlich type are discussed. The Markovian master equation of the Pauli type for these interactions is not fulfilled by the diagonal elements $N(p,t) = a^+(p,t)a(p,t)$ of the one-particle density matrix operator (a^+a), as is the case for direct interactions between the considered particles, and it is found that such an equation describes the time evolution of another operator, $N'(p,t)$, which contains also the nondiagonal elements of (a^+a), and the two- and more-particle correlations. For this purpose the unitary transformation is applied, which transforms the hamiltonian into the form where the indirect interactions between the considered particles via boson field appear explicitly. These results seem to deny the popular opinions that the one-particle density matrix is sufficient for description of a system of noninteracting-with-each-other particles in interaction with another system, when the behavior of the first system is of only interest, and that the correlations between such particles cannot be created. (auth)

4008 SUM RULES AND THE ISOVECTOR FORM FACTOR. Bollini, C. G.; Giambiagi, J. J. (Univ., Buenos Aires). Nuovo Cimento (10), 45A: 1042-5(Oct. 21, 1966).

A sum rule that was previously obtained without the use of dispersion techniques but is similar to that of Fubini et al. (Nuovo Cimento: 40A, 117(1965)) is applied to the calculation of the isovector form factor. (L.B.S.)

4009 GREEN FUNCTION FOR COMPOSITE PARTICLES. Braun, M. A.; Senyushkin, V. B. (Leningrad State Univ.). Zh. Eksp. Teor. Fiz., 51: 921-7(Sept. 1966). (In Russian).

The possibility of setting up a composite particle Green function in the scalar field model is considered. It is shown that the Green function can be written down only in the case of contact interaction when the Bethe–Salpeter equation is invalid. (auth)

4010 EQUAL TIME COMMUTATION RELATIONS AND SUM RULES. Bollini, C. G.; Giambiagi, J. J. (Univ. of Buenos Aires). Nucl. Phys., 87: 465-9(1966).

The connection between the algebra of currents and equal time commutation relations is used to give a simple derivation of sum rules. Its relation with Fubini's method and results for the same problem are discussed. (auth)

Electromagnetic

4011 (JINR-E2-2931) DISPERSION SUM RULES AND THE HYPERON MAGNETIC MOMENTS. Pisarenko, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 9p. Dep. mn.

The values of the hyperon magnetic moments are obtained from the dispersion sum rules for the virtual photoproduction of the pseudoscalar mesons on baryons. The results are in agreement with the SU(3) predictions and are compared with the experiment. (auth)

4012 (JINR-P2-2930) DISPERSIONNYE PRAVILA SUMM V STATICHESKOI MODELI. (Dispersion Sum Rules in the Static Model). Pisarenko, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 9p. (In Russian). Dep. mn.

Dispersion sum rules are obtained for strong and electromagnetic nucleon interactions in the static model. The results are in good agreement with experiment at low energies. (auth)

4013 (JINR-P2-2954) RASPADY ADRONOV S $\Delta S = 1$, $\Delta Q = 0$ V MODELI KVARKOV. ($\Delta S = 1$, $\Delta Q = 0$ Decays of Hadrons in the Quark Model). Ignatovich, V. K.; Struminskii, B. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab of Theoretical Physics). 1966. 7p. (In Russian). Dep. mn.

The $\Delta S = 1$, $\Delta Q = 0$ decays of hadrons are considered in the framework of the quark model. The hyperon and meson decays are described by one phenomenological parameter. The decay rates for $\Sigma^+ \to p + \gamma$, $K^+ \to \pi^+ e^+ + e^-$; $K_2^0 \to 2\gamma$ are calculated. The results are in good agreement with experiment. (auth)

4014 ELECTROMAGNETIC INTERACTIONS OF SPINOR, PSEUDO-SCALAR, AND VECTOR PARTICLES. Ramakrishnan, A. (MATSCIENCE, Madras). pp 478-91 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

A rapid survey of electromagnetic interactions of pseudoscalar, spinor, and vector particles is given in order to emphasize that electrodynamics can be considered to be a highly developed and complete theory only when the interactions of the photon with a spin-½ particle is considered assuming no other type of interaction exists. (J.F.P.)

4015 ALGEBRA OF CURRENTS AND THE OPERATORS AT $t = \pm \infty$. Kitakado, Shinsaku; Toyoda, Akira (Nagoya Univ., Japan). Progr. Theoret. Phys. (Kyoto), 36: 653-4(Sept. 1966).

The problem of treating contributions from various operators in the infinite past or future using current algebra is considered. As an illustration the derivation of the Kroll-Ruderman theorem is reinvestigated taking the process $\gamma + p \to n + \pi^+$. It is found that the same sum rules can always be obtained either by allowing for the mass difference and neglecting the operators in the infinite future or by considering the contribution from the operators at the surface $t = \pm \infty$ and assuming the same mass for the nucleons. (J.F.P.)

4016 PHOTOPRODUCTION OF A VECTOR MESON ON A NUCLEON. Nelipa, N. F. (Lebedev Inst. of Physics, Moscow). Nucl. Phys., 87: 444-50(1966).

The amplitude for photoproduction of a vector meson on a nucleon is analyzed. The spin structure, cms expression and partial wave expansion are obtained. (auth)

4017 ELECTROPRODUCTION OF PIONS FROM COMPLEX NUCLEI. Devanathan, V. (Univ. of Virginia, Charlottesville). Contract AT(40-1)-2915. Nucl. Phys., 87: 397-406(1966). (ORO–2915-51).

The amplitude for the electroproduction of pions from nucleons deduced by Fubini, Nambu and Wataghin is used for the study of electroproduction from complex nuclei. This extension is made using the impulse approximation. The structure of the single-nucleon transition amplitude is rather complex, and hence there are inherent difficulties in evaluating the transition probability in the case of a nucleus. It is shown how these difficulties can be overcome. The general expression for the cross section is deduced using the shell-model description for the nucleus, and the theory is illustrated by making numerical computation in the simple case of coherent electroproduction of pions from ^{12}C and ^{16}O. (auth)

4018 THE ELECTROMAGNETIC INTERACTION OF THE COMPOUND W^{+-} BOSON. Tirapegui, Enrique (Institut de Physique Nucleaire, Paris. Univ. Chile, Santiago). Compt. Rend., Ser. B, 263: 721-3(Sept. 19, 1966). (In French).

The electromagnetic interactions of the $W^{\pm}$ boson of the weak interactions was considered as compound in the sense of $Z_3 = 0$. It is shown that at the lowest order of the semi-weak coupling constant, the magnetic moment of W is equal to $g = 2$. (tr-auth)

4019 ELECTROMAGNETIC FORM FACTORS OF BARYONS AND QUARK MODEL. Ishida, S. (Nihon Univ., Tokyo); Konno, K.; Shimodaira, H. Nuovo Cimento (10), 46A: 189-93 (Nov. 1, 1966).

It is pointed out that the experimental behavior of electromagnetic form factors of the nucleon can be explained on the basis of the quark model and that the form factors of other baryons can be derived on the same basis. (L.B.S.)

4020 ELECTROMAGNETIC MASS DIFFERENCES OF BARYONS AND QUARK MODEL. Ishida, S. (Nihon Univ., Tokyo); Konno, K.; Shimodaira, H. Nuovo Cimento (10), 46A: 194-200 (Nov. 1, 1966).

Electromagnetic mass differences of baryons are investigated in the quark model. The basic assumption used is that the electromagnetic mass shift of the baryon is due to both electromagnetic interaction between constituent quarks and the electromagnetic mass shift of the quark itself. The calculated results agree fairly well with experiment. (L.B.S.)

4021 ELECTROMAGNETIC FORM FACTORS OF NUCLEONS. Beckmann, Peter E. (Univ., Mainz). Fortschr. Phys., 14: 235-57(1966).

A survey is given on the theoretical and experimental study of the electromagnetic form factor of nucleons. 22 references. (L.B.S.)

4022 PROPOSED EXPERIMENT TO DETECT THE MASS SHIFT OF AN ELECTRON IN AN INTENSE PHOTON FIELD. Reiss, Howard R. (Naval Ordnance Lab., Silver Spring, Md.). Phys. Rev. Lett., 17: 1162-3(Nov. 28, 1966).

An experiment in which a frequency shift in atomic spectra would be sought as evidence of the theoretically predicted mass shift of an electron in an intense photon field is proposed. It is shown that the effect would be readily measurable if it exists. (auth)

4023 PROPERTIES OF RELATIVISTIC BOUND STATES. Ciafaloni, M.; Menotti, P. (Scuola Normale Superiore, Pisa, Italy. Istituto Nazionale di Fisica Nucleare, Pisa, Italy). Nuovo Cimento (10), 46A: 162-70(Nov. 1, 1966).

Some properties of two-boson bound states for very high binding energy are examined in the Bethe-Salpeter framework. The relativistic nature of the high binding energy limit is pointed out and a proof is given of the enhancement of magnetic moments for a scalar interaction. (auth)

4024 UNIVERSAL COUPLING OF VECTOR MESONS REVISITED. Krolikowski, W. (International Atomic Energy Agency, Trieste, Italy). Nuovo Cimento (10), 46A: 106-14(Nov. 1, 1966).

It is shown that the partial conservation of a tensor current (PCTC) leads to a universality of vector-meson interactions, without assuming the Sakurai hypothesis on universal coupling of vector mesons to currents of symmetry generators. Meson electromagnetic decays are discussed on the grounds of PCTC and the results compared with the Sakurai universality. (auth)

4025 BREMSSTRAHLUNG IN HIGH-ENERGY ELECTRON COLLISIONS. Baier, V. N.; Fadin, V. S.; Khoze, V. A. (Novosibirsk State Univ., Siberia). Zh. Eksp. Teoret. Fiz., 51: 1135-42(Oct. 1966).

Single bremsstrahlung in high-energy electron collisions is considered. The angular distribution and spectrum of the emitted photons in the cms and ls are calculated. Radiation due to the incident particle and recoil particle is considered in the ls case. The classical current and Weizsacker–Williams methods are analyzed and it is shown that the latter method is not valid for calculating the spectrum of photons emitted by recoil particles if $\omega > m/2$. (auth)

Weak

Refer also to abstract 4018.

4026 NEXT NEUTRINO EXPERIMENTS. Ramm, C. A. CERN Cour., 6: 211-17(Nov. 1966).

The properties of neutrinos are discussed, and methods for determining these properties are considered. Topics covered include the sun and nuclear reactors as sources of the electronic neutrino, methods for detecting solar and cosmic neutrinos, laboratory neutrino experiments, previous proton synchrotron experiments the heavy liquid bubble chamber, and the neutrino beam. Also work at laboratories other than CERN, and future experiments are discussed. (J.F.P.)

4027 WEAK RADIATIVE DECAY OF HYPERONS. II. Toda, Azuma (Tohoku Univ., Senda!). Progr. Theoret. Phys. (Kyoto), 36: 657-8(Sept. 1966).

The decay amplitudes of a weak radiative decay of hyperons $Y \rightarrow B + \pi + \gamma$ including that of Λ, Σ, and Ξ are discussed. The method of current algebra together with the $\bar{U}(12)$ symmetry is applied to the radiative decay, and a sum rule is sought for the decay amplitudes of this process. Contributions to each mode of radiative decay and sum rules for the parity violating amplitude are found and listed. (J.F.P.)

4028 COVARIANT WAVE EQUATIONS FOR MASSLESS PARTICLES. McKerrell, A. (Princeton Univ., N. J.). Ann. Phys. (N. Y.), 40: 237-67(Nov. 1966).

A theory of covariant wave equations for massless particles is set up, based on wave functions transforming according to the finite-dimensional nonunitary representations (ab) of the homogeneous Lorentz group. For each $\lambda = -a-b, -a-b+1, \ldots, a+b$, there are sets of covariant subsidiary conditions which, subject to generalized gauge invariance, guarantee that the wave functions describe only particles of zero mass and helicity λ, and that an invariant scalar product exists, under which the representation of the inhomogeneous Lorentz group is unitary as well as irreducible. In this way it is proved that there are infinitely many covariant theories for a massless particle with any given helicity, and a procedure for constructing any such theory is given. The representations are extended to include negative energy, and a Foldy-Wouthuysen transformation derived. It is shown how to give covariant definitions of space and time inversion in the theory. (auth)

4029 PHENOMENOLOGICAL MODEL OF CP-CONSERVING NONLEPTONIC WEAK DECAYS OF MESONS. Delaney, Robert M. (Argonne National Lab., Ill. St. Louis Univ.); Welling, Daniel J. Phys. Rev. Lett., 17: 1164-6(Nov. 28, 1966).

A phenomenological model using currents which transform oppositely under C is proposed to explain those CP-conserving nonleptonic processes involving two and three mesons in the final state. The model makes use of the Kemmer field which satisfies given equations of motion. A phenomenological CP-invariant Lagrangian is used to describe two-meson (π) decays of mesons (K). Also rate comparisons for three-meson (π) modes of mesons (K) decays are listed and compared with experimental values. (J.F.P.)

4030 INTERMEDIATE VECTOR BOSON EFFECTS IN HIGH-ENERGY νN ELASTIC REACTIONS. Zhu, Xi-wen; He, Xiang-sheng; Zeng, Xi-zhi (Academia Sinica, Peking). Wu Li Hsueh Pao, 22: 945-51(Aug. 1966). (In Chinese).

Using the intermediate vector boson (IVB) theory and Cabibbo's SU_3 model for the weak interaction, the analytical expressions and numerical results for the differential cross sections and the longitudinal polarizations of the final state particles of several νN "elastic" reactions were obtained. The results show that, for the given set of form factors usually assumed, the IVB effects on the longitudinal polarizations of the leptons and the hyperons are substantial near certain outgoing angles when the neutrino energy is high enough. The results also show that some information about the form factors and the mass of the IVB can be obtained from the experimental results of the differential cross section and the longitudinal polarization taken together if they are accurate enough. The nuclear effects and the effect of the neutrino beam energy spectrum on the longitudinal polarization of the muon were also estimated for the process $\nu_\mu + [Z,A] \rightarrow \mu^- + [Z+1,A]$. (auth)

4031 η AND X^0 MESON PRODUCTION BY NEUTRINOS AND THE POSSIBLE EXISTENCE OF SECOND-CLASS CURRENTS. Berends, F. A. (CERN, Geneva); Singer, P. Nuovo Cimento (10), 46A: 89-105(Nov. 1, 1966).

The influence of possible second-class currents on η and X^0 production by neutrinos is investigated. If these currents have the same strength as first-class currents, they could give the major contribution to the cross sections. (auth)

Strong (General)

4032 (CALT-68-103) RELATIVISTIC QUARK MODEL AS REPRESENTATION OF CURRENT ALGEBRA. Gell-Mann, Murray (California Inst. of Tech., Pasadena). Oct. 1966. Contract AT(11-1)-68. 39p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The relativistic quark model as a representation of current algebra is discussed. Topics included are current algebra at infinite momentum, relativistic representation of current algebra, relation to approximate symmetry, covariant formalism, and an example in which mesons made of a free Dirac quark and a free Dirac antiquark are solved in both covariant and noncovariant formalisms. (B.G.D.)

4033 (JINR-E2-2973) ELEMENTARY PARTICLES OF THE LARGEST MASSES (QUARKS, MAXIMONS). Markov, M. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 9p. Dep. mn.

An idea of existence of elementary particles of the largest masses (maximons): $m_1 = e/\sqrt{\kappa} \approx 10^{-6}$g, $m_0 = \sqrt{hc/\kappa} \approx 10^{-5}$g based on the general theory of relativity, is presented, and all possible quark properties of these particles are considered. The possibilities of cosmological treating of the elementary particle problem are considered. (auth)

4034 EFFECTS OF ABSORPTION ON THE REAL PHASE SHIFT. Hida, Gyo; Yano, Tadashi (Univ. of Hiroshima). Progr. Theoret. Phys. (Kyoto), 36: 658-60(Sept. 1966).

The effects of absorption in the two-channel model are examined by using the Schroedinger equation, and the result is compared with that of the optical model. The energy dependence of the s- and p-wave phase shifts and reflection parameters are given for the two-channel model and the optical model. It is found that the imaginary potential and the coupling potential give contributions to the real phase shift which are of opposite sign. It is noted that the real part of the scattering amplitude is still negative for the optical model and positive for the two-channel model at fairly high energy owing to the contributions from the higher partial waves in the calculation. (J.F.P.)

4035 MANY-BODY-SYSTEM-LIKE STRUCTURE OF THE BASIC PARTICLE. Tati, Takao (Univ. of Hiroshima). Progr. Theoret. Phys. (Kyoto), 36: 655-6(Sept. 1966).

It is asserted that the observed pattern of N* levels containing many high J levels constitutes experimental support for the suggestion that the potential between basic particles is square-well-like rather than Yukawa-like. This suggests that the force between basic particles is qualitatively different from that mediated by a boson assumed ad hoc. It is suggested that according to a previously suggested model of the strong interaction the basic particle has a many-body-system-like structure and consequently the potential between basic particles becomes square-well-like. (J.F.P.)

4036 COMPOSITE MODELS OF HADRONS AND HIGH-ENERGY SCATTERING. Ram, Michael (Johns Hopkins Univ., Baltimore). Phys. Rev. Lett., 17: 1222-4(Dec. 12, 1966).

The assumptions of simple additivity of quark amplitudes and SU(2) invariance were applied to derive relations among hadron total cross sections, assuming hadrons to be composites of integral charge particles. The results are compared with those obtained from the conventional quark model. (auth)

4037 EMPIRICAL ONE-TO-ONE CORRESPONDENCE BETWEEN THE MASS SPECTRA OF BOSONS AND NUCLEON ISOBARS. Maglic, B. C. (CERN, Geneva). Nuovo Cimento (10), 45A: 949-58(Oct. 21, 1966).

Masses of heavy bosons and "subtracted masses," of nucleon isobars $m^* = M_{N^*} - M_{nucleon}$, are clustered around the same values: for each of 13 established bosons there is an N* whose subtracted mass is within 3% equal to the boson mass and vice versa. There are no bosons in the middle region between two clusters, which are regularly (230 ± 35) MeV apart. Combined spin parities of the bosons whose quantum numbers are certain (η, ρ, ω, F^0 and A_2) with that of the nucleon in l = 1 state given the known spin parities of their nearest N*'s. The observed boson-isobar correspondence suggests a physical picture of the N*'s as either composite states (resonances or bound states) of nucleons and heavy bosons, or as heavy boson threshold effects. (auth)

4038 ELEMENTARY PARTICLES WITH LARGEST POSSIBLE MASSES (QUARKS AND MAXIMONS). Markov, M. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz., 51: 878-90(Sept. 1966). (In Russian).

In field theory, which includes gravitation, expressions appear (in quantum as well as in the classical region) for the characteristic masses: $m_0 = (\hbar c/\varkappa)^{1/2}$, $m_1 = e/\varkappa^{1/2}$. An attempt is made to consider these masses as the largest possible ones for elementary particles (maximons). A remarkable property of these mass values is that only for these values does a peculiar mechanism arise (small mass gravitational collapse) which makes possible the formation of arbitrarily small mass systems from the maximons. The peculiar properties of the particles and their relation to quarks are discussed. (auth)

4039 POSSIBILITY OF IDENTIFYING THE LINES OF THE QUARK-ATOM Mg q II AND Hq IN THE SPECTRUM OF THE SUN. Vainshtein, L. A.; Pikel'ner, S. B. (Lebedev Inst. of Physics, Moscow. Shternberg State Astronomical Inst., USSR). JETP Lett. (USSR) (Engl. Transl.), 4: 207-9(Oct. 15, 1966).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 4: 307-11(Oct. 15, 1966).

The position of the center of gravity of the doublet (Λ) for the resonant line Mg q II (3s−3p) was determined by extrapolating to $Z = 5/3$ the experimental data for Na I, Mg II, and Al III. The observations are found not to contradict the presence of quarks in the solar atmosphere, but the uncertainties in the determination of the line parameters should be reduced. (J.F.P.)

4040 THE TREIMAN–YANG CRITERION FOR PARTICLES WITH SPIN. Shapiro, I. S.; Kolybasov, V. M. (Inst. of Theoretical and Experimental Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 4: 221-3(Oct. 15, 1966).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 4: 329-32(Oct. 15, 1966).

It is shown that the statement that the Treiman-Yang criterion is satisfied in the relativistic case when a particle with spin ½ is exchanged is incorrect and that a number of cases when the Treiman-Yang criterion is satisfied, given previously, remain valid for nuclear reactions at high energies when the first vertex of the pole diagram is nonrelativistic and the other one is relativistic. (J.F.P.)

Strong (Baryon No. = 0)

4041 (JINR–E1-2941) QUARK MODEL OF BACKWARD SCATTERING. Lyubimov, A. L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1966. 7p. Dep. mn.

The consequences of the quark exchange model for backward scattering, concerned with the shape of the elastic backward scattering peak and antibaryon-baryon interaction, are considered. On the basis of the available experimental data on backward scattering an assumption is made about the additivity of two-body quark exchange amplitude. It is shown that considerations developed can be also applied to the exchange of different quarks in two-particle inelastic reactions. (auth)

4042 REGGE POLE REPRESENTATION FOR THE EXCHANGED ρ RESONANCE. Imoto, Michiko (Tokyo Metropolitan Univ.). Progr. Theoret. Phys. (Kyoto), 36: 649-51(Sept. 1966).

A method of treating the meson (ρ) in meson (π)-meson (π) scattering is proposed. The ρ resonance is treated as a Regge trajectory in a form appropriate to the calculation of the partial wave amplitude. In the dispersion relation for the p wave amplitude the contribution from the left-hand cut can be calculated in terms of physical scattering in the t and u channels by using crossing symmetry. (J.F.P.)

4043 SUM RULES FOR THE DETERMINATION OF s- AND p-WAVE PION–PION SCATTERING LENGTHS. Pisut, J.; Lichard, P.; Bona, P. (Komenskeho Univ., Bratislava). Nucl. Phys., 87: 433-43(1966).

Sum rules for the determination of s- and p-wave $\pi\pi$ scattering lengths are obtained from the dispersion relations for forward scattering. The calculated values of scattering lengths are $\alpha_0 = -1.3 \pm 0.6$; $\alpha_2 = 0.38 \pm 0.2$ and $\alpha_1^1 = 0.037 \pm 0.004$. The importance of Adler's $\pi\pi$ sum rule for obtaining the information on the α_0 scattering length is briefly discussed. (auth)

4044 THE TOTAL $\pi\pi$ CROSS SECTION AND THE WIDTH OF THE FORWARD DIFFRACTION PEAK AT HIGH ENERGY. Igi, K.; Kawai, T. (Tokyo Univ. of Education). Nuovo Cimento (10), 45A: 1019-26(Oct. 21, 1966).

The $\pi\pi$ scattering was investigated at low-momentum transfers, in order to understand diffraction scattering. High-energy effects at low-momentum transfers are automatically included by solving the integral equations with the short-range potential in addition to the long-range potential. Dynamical predictions are made on the magnitude of the total cross section and the width of the forward diffraction peak, starting from a knowledge of the low-energy resonance parameters. (auth)

4045 HIGH-ENERGY BEHAVIOR OF FEYNMAN INTEGRALS WITH SPIN. I. Greenman, J. V. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. J. Math. Phys. (N. Y.), 7: 1782-96(Oct. 1966).

A method of determining the leading behavior of planar graphs for two-body processes in a spin-½−spin-1 conserved vector current theory is outlined. The leading behavior can be found by inspection. Coefficients of lower-order terms can be found explicitly. This method together with analysis of nonplanar graphs to justify the Reggeization hypothesis in nth order is proposed for future work. (auth)

4046 CONSTRUCTION OF THE EQUIVALENT POTENTIAL IN BORN APPROXIMATION FOR SCATTERING BY PARTICLES OF UNEQUAL MASS. DerSarkissian, M. (Univ. of California, Berkeley). Contract W-7405-eng-48. Nuovo Cimento (10), 46A: 39-46(Nov. 1, 1966). (UCRL–16748).

The construction of the configuration space equivalent potential in Born approximation is considered for scattering by particles of unequal mass. The potential agrees in essence with the one obtained using the Chew-Frautschi prescription in S-matrix theory, i.e., the range of the exchange force arising from the exchange of a particle of mass M_p is $R_0 = [M_p^2 - (M_A^2 - M_B^2)^2/s]^{-1/2}$ where M_A, M_B are the masses of the particles involved in the scattering and s = (c.m. energy of (A,B))^2. This clarifies the confusion in the recent literature regarding this point and sets the stage for determining the importance of the energy dependence of the range parameter in studying the dynamics of strongly interacting particles. The examples considered are K* (890) exchange in πK scattering and N exchange in πN scattering. It is shown that the energy dependence of the range parameter is not important in the former and may be crucial in the latter. (auth)

Strong (Baryon No. = 1)

Refer also to abstracts 4012 and 4046.

4047 LOW ENERGY $\pi^- - N$ SCATTERING WITH NUCLEON ON A REGGE TRAJECTORY. Trivedi, U. (Tata Inst. of Fundamental Research, Bombay). pp 529-34 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

A previously proposed ansatz which treats the nucleon as lying on a Regge trajectory is considered, and an ansatz based on scattering by a Yukawa potential which incorporates desired features not appearing in the former ansatz is presented. It is found that it is thus possible to give a Regge-pole description of the $(1/2, 1/2)$ phase shift consistent with the physical one given by Chew. It is emphasized that the hypothesis of the nucleon as lying on a Regge trajectory is not in conflict with experiment, that this trajectory is dominant in the low-energy region, and that rho exchange is responsible for the turning of the phase shift. (J.F.P.)

4048 REGGE-POLE EXCHANGE ANALYSIS OF SOME HIGH ENERGY INELASTIC PROCESSES. Roy, D. P. (Tata Inst. of

Fundamental Research, Bombay). pp 548-56 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

Charge exchange $K^- + p$ scattering and the production processes $\pi^- + p \rightarrow \pi^0 + N^*$, $\pi^- + p \rightarrow \omega + N^*$, and $K^- + p \rightarrow K^0 + N^*$ are studied at a few GeV using the Regge-pole exchange mechanism. With constraints of various quantum numbers in the t channel it is seen that amongst the known particle trajectories only rho exchange can contribute to these reactions. Then the respective amplitudes are obtained in terms of the rho trajectory α (t) and the residues. The values of the trajectory parameter α (t) are taken from charge exchange π^--p scattering data, and the t dependence of the residues (with the threshold factor extracted out) are neglected. Then the latter are obtained in terms of the field theoretic coupling constants using the fact that the Regge-pole exchange is identical to the corresponding elementary particle exchange at the pole point. Thus the production cross sections contain no arbitrary parameters. The magnitude and also the energy and momentum-transfer dependence of these cross sections are found to be in broad agreement with experimental data. (auth)

4049 ISOSPIN ½ AMPLITUDES IN THE π-N INTERACTION. Moyer, B. J. (Indian Inst. of Tech., Kanpur, India). pp 562-9 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

Elastic and charge-exchange scattering of pions by protons allows determination of the pure $T = ½$ scattering. This was studied over the energy region including the first three point-nucleon resonances. The region near the cross-section maximum at 1510 MeV (total c.m. energy) possesses strong p_{11} and D_{13} amplitudes, and an S_{11} amplitude behavior apparently related to the threshold for η^0 production. All of these are of pronounced inelastic character. The 1690 MeV resonance involves superposition of F_{15} and D_{15} amplitudes as its dominant character. The charge-exchange experiments also yield the cross sections and angular distributions for η^0 production. The relation of this to pion amplitudes is discussed. A possible cause of the P_{11} amplitude strength is seen in the $T = 0$, $J = 0$, $\pi-\pi$ interaction. (auth)

4050 QUARK MODEL AND π N BACKWARD SCATTERINGS. Namiki, Mikio; Ohba, Ichiro (Waseda Univ., Tokyo). Progr. Theoret. Phys. (Kyoto), 36: 651-3(Sept. 1966).

The backward behavior of π N elastic and charge exchange scattering is discussed. The quark model is adopted. The ratios for the cross sections for backward $\pi^+ + p \rightarrow \pi^+ + p$, $\pi^- + p \rightarrow \pi^- + p$, and $\pi^- + p \rightarrow \pi^0 + n$ scattering are found and given. Experimental values are also listed. (J.F.P.)

4051 COMMUTATION RELATIONS FOR CURRENT DENSITY COMPONENTS. Sokolov, V. V.; Khriplovich, I. B. (Novosibirsk State Univ., USSR). Zh. Eksp. Teor. Fiz., 51: 854-7 (Sept. 1966). (In Russian).

The nucleon current density is defined in a symmetric pseudoscalar meson theory with pseudovector coupling in such a way that it does not commute with the canonical meson field momentum. Some properties of the theory are discussed. (auth)

4052 PRODUCTION AND DECAY OF VECTOR MESONS AT HIGH ENERGY. Bialas, A. (Jagellonian Univ., Krakow); Svensson, B. E. Y. Nuovo Cimento (10), 46A: 59-76(Nov. 1, 1966).

Analyticity and crossing properties of helicity amplitudes are used to discuss production and decay of vector mesons (ρ, ω, K^*) in high-energy ($p_{lab} \gtrsim 3$ GeV/c) meson-nucleon collisions, much in the same way as elastic scattering. Asymptotic relations between the cross sections and the decay angular distributions for a vector meson and its antiparticle are derived. The restrictions on the decay distributions following from exchange of definite parity and charge-parity are discussed. A nondynamical approach, using the assumption of a common phase for all amplitudes, is proposed and successfully compared to the experimental data. (auth)

4053 SIGN OF DIFFERENCE OF THE REAL PARTS OF THE ELASTIC PION–PROTON SCATTERING AMPLITUDES IN THE VERY HIGH ENERGY REGION. Barashenkov, V. S.; Truskowa, N. F. (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Pol., 30: 427-9(Sept. 1966).

In order to investigate the problem of a possible violation of dispersion relations in elastic $\pi^+ + p$ and $\pi^- + p$ scattering, the high energy behavior of ΔT, where T is the energy, is studied. It is found that by means of dispersion relations agreement is not obtained with the experimental data on the $\pi^- + p$ charge exchange cross section and on the energy dependence of the total cross sections for $\pi^\pm + p$ interactions in the interval $T \simeq 5$ to 20 GeV with the experimental values of the real part of the elastic $\pi^\pm + p$ scattering amplitudes. (J.F.P.)

4054 SYSTEMATIC PROPERTIES OF PION–NUCLEON SCATTERING AMPLITUDES. Oades, G. C. (NORDITA, Copenhagen). Nuovo Cimento, Suppl. (1), 4: 217-30(1966).

Fixed-energy dispersion relations are used to obtain explicit expressions for the various terms contributing to the pion–nucleon partial-wave amplitudes. The expressions are then used to deduce the general qualitative feature of these amplitudes. (L.B.S.)

4055 THE PIONIC FORM FACTOR OF THE FIRST πN RESONANCE. Gutbrod, F. (Deutsches Elektronen-Synchrotron, Hamburg). Nuovo Cimento (10), 45A: 830-46(Oct. 21, 1966).

Off-shell πN-scattering in the $^3/_2$, $^3/_2$ state is treated by the Omnès-Muskhelishvili method. The left-hand cut is represented by nucleon exchange and by approximate double spectral functions coming from iterations of nucleon exchange, and on the right-hand cut some inelasticity is assumed. The off-shell amplitude is roughly determined by the behavior of the Born term taken at resonance energy, but is not insensitive to the absorption at high energies. If the form factor is approximated by a single pole in momentum transfer, the relevant mass is 1.5 nucleon masses. (auth)

4056 THE N/D METHOD OFF THE MASS SHELL. Petras, M. (Komenskeho Univ., Bratislava). Nucl. Phys., 87: 451-64 (1966).

An extension of the N/D method off the mass shell is considered in some particular cases, which incorporates the nonrelativistic and the relativistic, though static, two-particle scattering. Equations are derived which permit the determination of the wave functions and potentials from the usual N/D input data (left-hand singularities). The method is illustrated by the particular case of static πN scattering. (auth)

Strong (Baryon No. ≥ 2)

4057 (INR–736/VI/PH) ON THE LOWER LIMIT OF TRANSVERSE MOMENTUM AND FOUR-MOMENTUM TRANSFER OF RECOIL PROTONS IN NUCLEON–NUCLEON INTERACTIONS OF ENERGIES ABOVE 10^{12}eV. Babecki, J. (Institute of Nuclear Research, Warsaw (Poland)). July 1966, 16p. Dep.

The determination of transverse momentum and four-momentum transfer of recoil protons in nucleon-nucleon interactions of ultra high energy on the basis of kinematical analysis of angular distributions of secondaries in cosmic ray jets is described. The method applied consisted in calculating the transverse momentum for all relativistic tracks assuming that the given track is due to a proton and in the selection of the smallest value out of all possible values of $p_\perp$. (auth)

4058 (JINR-E1-2953) SPECIFICATION OF THE N-N PHASE SHIFT ANALYSIS AT 147 MeV. Kazarinov, Yu. M.; Legar, F.; Yanout, Z. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1966. 31p. Dep. mn.

Specification of the N-N phase shift analysis at 147 MeV was performed by using all data available at the energies near to 147 MeV. The data on effective cross section of np- and pp-scattering and pp-scattering polarization were normalized to this energy. The angular dependences of the experimental quantities were calculated and are presented. (auth)

4059 (JINR–P–2890) PRIBLIZHENNYI METOD RESHENIYA ZADACHI TREKH NUKLONOV S TSENTRAL'NYM VZAIMODEISTVIEM. (An Approximate Method of Solving the Three-Nucleon Problem With Central Interaction). Efimov, V. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1966. 22p. (In Russian). Dep. mn.

The Bubnov-Galerkin's method is applied to solve the three-nucleon problem. According to this method the wave functions are expanded (in the region where the potential acts) in a complete set of basic functions, which depend on the distance between two nucleons and which are orthogonal to the weight, determined by the radial dependence of the potential. The method allows one to reduce the solution for the three-nucleon problem to the solution for the system of integral equations. The elastic n-d scattering amplitude is expanded in a power series in the small parameter. (auth)

4060 P–P AND N–p SCATTERING BASED ON TRANSVERSE MOMENTUM DISTRIBUTION AND MANDELSTAM REPRESENTATION. Chavda, L. K.; Narayan, D. S. (Tata Inst. of Fundamental Research, Bombay). pp 535-45 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

For the study of proton–nucleon scattering a representation of the angular dependence is modified such that a scattering ampli-

tude can be derived from it which has the Mandelstam singularity structure and which leads to the empirically observed transverse momentum dependence for small and large values of the angular distribution. This result is then generalized to obtain the full scattering amplitude for p-p scattering involving both spin-flip and nonspin-flip parts of the amplitude. Finally the treatment is extended to obtain the amplitude for n−p direct and charge exchange scattering. The agreement with experiment of this model shows that the same pattern of interaction and the same forces responsible for the p−p scattering also determine the n−p direct and charge exchange scatterings. (J.F.P.)

4061 DEUTERON PRODUCTION IN PROTON–PROTON COLLISIONS. Patnaik, P. K.; Deo, B. (Indian Inst. of Tech., Kanpur, India). pp 557-61 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

The one-nucleon exchange mechanism for the reaction $p + p = d + \pi^+$ is studied. In the BeV region, the exchange neturon is far off its mass shell. So the n-d-p vertex function is formulated with much care. The calculated cross sections show some of the desired experimental features, but do not agree completely with them. (auth)

4062 ARE MULTIPLE SCATTERING MEASUREMENTS AFFECTED BY THE INTERFERENCE BETWEEN THE COULOMB AND NUCLEAR SCATTERING AMPLITUDES? Faucher, G. (Faculte des Sciences, Paris). Nuovo Cimento (10), 46A: 201-3 (Nov. 1, 1966).

Interference effects between coulomb and nuclear scattering is investigated for scattering of 25- and 27- GeV/c protons in nuclear emulsions, using the eikonal approximation. Calculations are made which show that the presence of interference effects will not alter the measurements of multiple scattering. (L.B.S.)

4063 A COMPARISON OF THE ABSORPTION MODEL AND A REGGE POLE MODEL FOR NUCLEON ISOBAR EXCITATION. Margolis, B.; Rotsstein, A. (McGill Univ., Montreal). Nuovo Cimento (10), 45A: 1010-18(Oct. 21, 1966).

A comparison is presented of the predictions of the absorption model and the Regge-pole hypothesis for the production, at small momentum transfers, of nucleon isobars in proton-proton scattering in the incident momentum range of (5.5 to 30) GeV/c. The study is applied to the nucleon isobars of mass 1238 MeV, 1400 MeV, 1512 MeV and 1688 MeV, respectively. Reasonable agreement with experiment is obtained for the production of the 1238 MeV isobar (isospin $T = \frac{3}{2}$) assuming pion exchange using either the absorption model or a Regge-pole model. Pion exchange does not appear to account for the production of the $T = \frac{1}{2}$ isobars (1400 MeV, 1512 MeV and 1688 MeV). The production of the latter has features which are characteristic of domination by the Pomeranchuk trajectory. (auth)

4064 DYNAMICAL CONDITIONS IN A SIMPLE SOLUBLE MODEL. Eftimiu, C. (Univ., Bonn). Nuovo Cimento (10), 45A: 1033-7(Oct. 21, 1966).

The relation between the conditions characterized by the vanishing of the form factor and the vanishing of the proper vertex under which an elementary particle appearing among the intermediate states of a scattering process turns into a dynamical Regge-like particle is investigated in a simple soluble model. (L.B.S.)

4065 RELATIVISTIC RECONSTRUCTION OF N–N SCATTERING MATRIX. Bilenkii, S. M.; Lapidus, L. I.; Ryndin, R. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz., 51: 891-906(Sept. 1966). (In Russian).

It is shown how the nucleon−nucleon scattering matrix can be reconstructed from the experimental data at fixed values of the angle and energy in the relativistic case. Different reconstruction procedures are considered. Relativistic formulae were obtained for reconstructing the nucleon−nucleon scattering matrix in the state with total zero isospin from the np and pp-scattering data. (auth)

Particle Invariance Principles and Symmetries

4066 LIE GROUPS FOR PEDESTRIANS. Second Edition. Lipkin, Harry J. New York, John Wiley and Sons, 1966. 190p. $6.50.

The well-known techniques of angular momentum algebra are extended to treat Lie groups and several examples illustrating the application of the method are presented. Topics discussed in this edition are: isospin; application of the group SU_3 to elementary particles; the three dimensional harmonic oscillator; algebra of operators which change the number of particles; permutations, bookkeeping, and Young diagrams; and the SU_4, SU_6, and SU_{12} groups. (B.G.D.)

General

Refer also to abstracts 4004 and 4108.

4067 (JINR–E2-2951) THEORY OF RELATIVISTIC SL(6,C) SYMMETRY. Dao vong Duc; Enkovski, L.; Kukhtin, V. V.; Montvai, I.; Nguyen van Hieu (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 26p. Dep. mn.

The technique of SL(6,C) symmetry with infinite multiplets is developed. Using homogeneous functions, the unitary representations of SL(6,C) are constructed. The decomposition of these representations into SU(6) multiplets and $SU(6)_p$ (physical) multiplets is investigated and the invariant meson-baryon vertex is constructed. For the vertex the connection between the theory with infinite multiplets under consideration and the nonunitary theory of intrinsically broken SL(6,C) symmetry is established. (auth)

4068 (JINR–P2-2928) PREDSTAVLENIYA NEKOMPAKTNYKH GRUPP I SISTEMATIKA ELEMENTARNYKH CHASTITS. (Non-Compact Group Representations and Elementary Particle Systematics). Todorov, I. T. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 7p. (In Russian). Dep. mn.

The degenerate discrete series of Hermitian representations of the Lie algebra of U(p,q) are classified. The content of all discrete representations of U(p,q) with respect to the maximal compact subgroup $U(p) \otimes U(q)$ is given. Previous results on hadron mass-spectrum, obtained in the framework of the ladder representations of U(6,6) are discussed. It is mentioned that the mass of the resonance in the $2K_1^0$ system observed recently is quite near to the predicted mass of the scalar singlet in the meson ladder. (auth)

4069 (JINR–P2-2957) O RASPADAKH CHASTITS V TEORII SIMMETRII S NEKOMPAKTNYMI GRUPPAMI. (Particle Decays in the Theory With Noncompact Groups). Bokov, O. G.; Mikhul, E.; Sredniava, B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 11p. (In Russian). Dep. mn.

The SL(2,C) group is considered as the internal symmetry group. The vector-coupling coefficients for the irreducible unitary representations of SL(2,C) are calculated. The matrix element for the decay of a spin-1 particle into two spinless particles is calculated. (auth)

4070 (JINR–P5-2950) VYROZHDENNYE UNITARNYE PREDSTAVLENIYA GRUPPY SU(2,2). (Degenerate Unitary Representations of the SU(2,2) Group). Chi, Cao (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 10p. (In Russian). Dep. mn.

Degenerate irreducible unitary representations of the SU(2,2) group are realized in the space of homogeneous functions f(z). Two series of representations (main and additional) were found, each of them is characterized by the pair of numbers (N,x), which are connected with the degrees of homogeneity F and $\tilde{F}$ of the function f(z) in the following way $N + 2x = F$ and $N - 2x = \tilde{F}$ and satisfy the definite conditions. (auth)

4071 (JINR–P5-2977) K TEORII UNITARNYKH PREDSTAVLENII GRUPPY SL(n,C). (Theory of SL(n,C) Group Unitary Representations). Doan Nhuong (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 17p. (In Russian). Dep. mn.

All possible unitary irreducible representations of the main (non-degenerate and degenerate) series of group SL(n,c) are discovered in the language of the homogeneous functions. The connection is established between the representations studied and the Gelfand-Naimark's representations. (auth)

4072 BOOT STRAP AND SYMMETRIES. Singh, Virendra (Tata Inst. of Fundamental Research, Bombay). pp 459-77 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

The relation of symmetry groups to nature and the kinetics of symmetry breakings are studied. The bootstrap approach to symmetries, symmetries out of meson bootstraps, the relation of symmetry to baryon bootstraps, and broken symmetry are considered. (J.F.P.)

4073 VIOLATION OF TIME REVERSAL INVARIANCE. Mani, H. S. (National Physical Lab., Delhi). pp 492-508 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

Various models which include CP violation are classified and reviewed. The CPT theorem is assumed, and thus a violation of CP invariance is the same as T violation. Experiments which were performed or proposed for testing T invariance are discussed. (J.F.P.)

4074 THEORY OF O(4) INVARIANT POTENTIALS AND ITS APPLICATION TO A SHORT-RANGE EXAMPLE. Luming, M.; Predazzi, E. (Univ. of Chicago). Contract AT(11-1)-264. Ann. Phys. (N. Y.), 40: 221-36(Nov. 1966). (COO-264-314; EFINS-66-27).

The eigenvalue problem for O(4) invariant potentials, which are in general energy-dependent and nonlocal (nonseparable), is solved exactly, and a general expression for the energy spectrum is derived. An example of such potentials is studied which has short-range characteristics in the bound-state region and whose low-lying levels are approximations to those of the Yukawa potential in the limit of large binding energies. (auth)

4075 INTERNAL POLARIZATION AND RELATIVISTIC ELEMENTARY-PARTICLE ALGEBRA. Takabayasi, Takehiko (Nagoya Univ., Japan). Progr. Theoret. Phys. (Kyoto), 36: 660-2(Sept. 1966).

The implications of the model for realizing by its various quantum states all physically relevant irreducible representations of the Poincaré group, and whose kinematical variables are given by its center-of-mass coordinates and a two-component spinor, are clarified. It is shown that the realization of the Poincaré group by this model naturally associates the symmetries of baryon gauge and antiparticle conjugation and also the dynamical symmetry group $U_a(2) \times U_b(2)$ relativistically. (J.F.P.)

4076 ANALYSIS OF SPACE-TIME STRUCTURE IN ELEMENTARY PARTICLE PHYSICS. Castell, L. (Trinity Coll., Dublin). Nuovo Cimento (10), 46A: 1-38(Nov. 1, 1966).

First the space-time structure of classical mechanics and quantum mechanics is analyzed in the framework of projective geometry. Dimensions are defined group-theoretically, and it is proved that classically the length dimensions of all physical measurable quantities are integers. The quantum-mechanical theory leads to a generalization of the Lie algebra of the inhomogeneous Lorentz group and the dilatations. There are two possibilities, the Lie algebra of the conformal group $SO_{4,2}$ and a contraction of it. Next the question arises naturally of whether one is able to define length dimensions and position at a subatomic level. An attempt is made to solve this problem by introducing an elementary length L, and connect the elementary length with the scale constant of a 5-dimensional pseudohyperbolic space. In the framework of projective geometry this space is the only nontrivial extension of the space of special relativity with an absolute invariant metric. The group of motion of this generalized space-time continuum, whose Lie algebra is isomorphic to the previously derived Lie algebra of $SO_{4,2}$, is investigated in detail, and so are the metric and the geodesics. Field equations and conservation laws are derived, and finally the quantization of the scalar field with a positive definite metric in Hilbert space is treated. (auth)

4077 MISSING SU(3) MULTIPLETS AND $SU(6)_W$ SELECTION RULES. Horn, D.; Lipkin, H. J.; Meshkov, S. (Argonne National Lab., Ill.). Phys. Rev. Lett., 17: 1200-3(Dec. 5, 1966).

W-spin selection rules which prohibit many resonances having high isospin and hypercharge from displaying dominant two-body decay modes, appearing as bumps in meson-baryon scattering cross sections, or being produced by simple peripheral meson exchange are presented. Thus, experimental evidence against the existence of these states is inconclusive, and a search for more complicated production mechanisms and decay modes is suggested. (auth)

4078 SU_3 COMPACT FORMULA FOR $D(m') \otimes D(m)$ AND FOR MULTIPLICITY $M^{m'}(m'')$ OF $m'' \in D(m')$. Gruber, B. (Istituto Nazionale di Fisica Nucleare, Naples); Santhanam, T. S. Nuovo Cimento (10), 45A: 1046-9(Oct. 21, 1966).

A simple formula in SU_3 is given for the multiplicity $M^{m'}(m'')$ of an arbitrary weight m'' contained in an irreducible representation $D(m')$ with highest weight m'. In addition, knowing $M^{m'}(m'')$, a compact and simple formula for the decomposition $D(m') \otimes D(m)$ is derived. (L.B.S.)

4079 TIME-REVERSAL INVARIANCE AND CROSSING RELATIONS, IN PARTICULAR FOR HELICITY AMPLITUDES. Svensson, B. E. Y. (Univ. of Lund, Sweden). Ark. Fys., 33: 93-102(1966).

Using reduction technique in local field theory, it is proved that, granting necessary analyticity properties, there always exist crossing relations between the analytically continued scattering (or production) amplitudes for a two-body elementary particle reaction $a + c \rightarrow b + d$ and the complex conjugate amplitudes for the "time-reversed crossed reaction" $\bar{a} + d \rightarrow \bar{b} + c$. The participating particles may have any spin. Separate invariance under C, P or T is not assumed, but CPT-invariance is implicit. The exact form of these crossing relations for helicity amplitudes is derived. (auth)

4080 ON AN ALGEBRAIC METHOD FOR THE DECOMPOSITION OF DIRECT PRODUCTS OF REPRESENTATIONS OF THE GROUPS $A_2(SU(3))$ AND $B_2(SO(5))$. Gruber, B. (Istituto Nazionale di Fisica Nucleare, Naples). J. Math. Phys. (N. Y.), 7: 1797-1801(Oct. 1966).

A prescription for the decomposition of the direct product of two irreducible representations of A_2 and B_2 is given, which is completely general and direct, i.e., it does not make use of any auxiliary means like Young tableau or Cartan–Stiefel diagrams although it is based on the latter. The addition of weights alone under the observation of certain rules gives the desired result. This method can in principle be generalized to the semisimple groups of arbitrary rank provided an algebraic expression for the multiplicities of the weights contained in an irreducible representation can be found. (auth)

4081 SOME REMARKS ON THE CONSTRUCTION OF INVARIANTS OF SEMISIMPLE LOCAL LIE GROUPS. Santhanam, T. S. (International Center for Theoretical Physics, Trieste, Italy). J. Math. Phys. (N. Y.), 7: 1886-?(Oct. 1966).

A general form of the l invariants of compact semisimple local Lie groups or rank l, as the traces of the powers of the velocity potential operator is suggested. The connection of this form of the invariants with those of Gruber and O'Raifeartaigh is described. The possible generalization beyond those of adjoint group and its connection with that of Biedenharn is discussed. (auth)

4082 CLASSIFICATION OF IRREDUCIBLE UNITARY REPRESENTATIONS OF COMPACT SIMPLE LIE GROUPS. I. Mehta, M. L. (Univ. of Delhi). J. Math. Phys. (N. Y.), 7: 1824-32(Oct. 1966).

An irreducible unitary representation of any group belongs to one of the three Wigner classes, potentially real, pseudo-real, or complex. The irreducible unitary representations of all the compact simple Lie groups except those of the type E are hereby classified. The similar classification for the simple groups E_6, E_7, and E_8 is completed in the next paper. (auth)

4083 CLASSIFICATION OF IRREDUCIBLE UNITARY REPRESENTATIONS OF COMPACT SIMPLE LIE GROUPS. II. Mehta, M. L.; Srivastava, P. K. (Univ. of Delhi). J. Math. Phys. (N. Y.), 7: 1833-5(Oct. 1966).

In continuation to a previous article, the classification of the irreducible unitary representations of the groups E_6, E_7, and E_8 into complex, potentially real, and pseudo-real categories is completed. (auth)

4084 DISCRETE DEGENERATE REPRESENTATIONS OF NONCOMPACT ROTATION GROUPS. I. Raczka, R.; Limic, N.; Niederle, J. (International Center for Theoretical Physics, Trieste, Italy). J. Math. Phys. (N. Y.), 7: 1861-76(Oct. 1966).

The discrete most degenerate principal series of irreducible Hermitian representations of the Lie algebra of an arbitrary noncompact as well as compact rotation group $SO(p,q)$ are derived. The properties of these representations are discussed and the explicit form of the corresponding harmonic functions is given. (auth)

4085 CONSISTENT RELATIVIZATION OF AN SU(6) GROUP FOR TWO-PARTICLE REACTIONS. Ogievetskii, V. A.; Polubarinov, I. V. (Joint Inst. for Nuclear Research, Dubna, USSR). JETP Lett. (USSR) (Engl. Transl.), 4: 218-20(Oct. 15, 1966).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 4: 325-9(Oct. 15, 1966).

A group $SU_x(6)$ isomorphic SU(6) is proposed. The group $SU_x(6)$ is a relativistic version of the SU(6) group with internal consistency, i.e., it leaves invariant the free equations and leads to noncontradictory limitations on the reaction amplitudes. This $SU_x(6)$ group is applicable to two-particle reactions without being confined to collinearity. (J.F.P.)

4086 REDUCTION OF THE RIGHT REGULAR REPRESENTATION OF INHOMOGENEOUS SL(n,C). Angelopoulos, Eughenios (Institut Henri Poincare, Paris). Compt. Rend., Ser. A, 263: 400-2(Sept. 19, 1966). (In French).

The Fourier image of the right regular representation of the unimodular, complex inhomogeneous group was decomposed into direct integrals of unitary, irreducible representations by using the orbital decomposition of the normal sub-group of the translations. (tr-auth)

4087 THE RELATIONSHIP BETWEEN THE GALILEI GROUP AND ANY INTERNAL SYMMETRY GROUP OF NON-RELATIVISTIC PARTICLES. Fleischman, O.; Nagel, J. G. (Syracuse Univ., N. Y.). Nuovo Cimento (10), 45A: 937-48(Oct. 21, 1966). (NYO-3399-48).

Seeking insights into the relationship between the internal and dynamical symmetries of relativistic particles, the analogous well-defined relation for an isolated nonrelativistic system of particles is explored. Denoting the center-of-mass position, momentum and mass by R, P and M the internal energy and angular momentum are $H_0 = H - P^2/2M$ and $S = J - R \times P$. A general intrinsic symmetry group is defined to be one whose generators commute with H_0, and a general internal symmetry group Z to be one whose generators commute with H_0, R and P. The dynamical inhomogeneous Galilei group $\overline{G}$, whose Casimir operators are H_0 and S^2, is then an intrinsic symmetry group. The group SU_2^{int} generated by S is an internal symmetry group and $SU_2^{int} \subset Z$. The Lie algebras of Z and $\overline{G}$ close to form the Lie algebra of the intrinsic symmetry group $\overline{I}$ of the system, which is the factor group of the semi-direct product $Z \otimes \overline{G}$ by the cyclic group C_2, i.e., $\overline{I} = (Z \otimes \overline{G})/C_2$. The Casimir operators of $\overline{I}$ are H_0 and the Casimir operators of Z. Angular momentum degeneracy for a given value of H_0 depends upon whether or not S^2 is a Casimir operator of Z. As examples of Z exhibiting this degeneracy the O_4 and $O_{3,1}$ of the hydrogen atom and the U_3 of the spinless two-particle isotropic harmonic oscillator are reviewed. (auth)

4088 ON THE DEGENERACY PROBLEM IN SU(3). Chew, C. K.; Sharp, R. T. (McGill Univ., Montreal). Can. J. Phys., 44: 2789-95(Nov. 1966).

The recent suggestion of Macfarlane, O'Raifeartaigh, and Rao that mixed Casimir operators be used to resolve the external degeneracy problem is applied to the group SU(3). The significant operator is the part of the cubic mixed Casimir operator which is antisymmetric with respect to the two factor spaces and also with respect to starred and unstarred variables. The matrix of this operator is derived with respect to a convenient set of functions and is found to have a simple form. The eigenfunctions are simply related to the usual symmetric and antisymmetric functions in the case of degeneracy 2 with equal factor representations. (auth)

Applications (Electromagnetic and Weak)

4089 (JINR-P-2894) SOOTNOSHENIYA SIMMETRII DLYA ELEKTROMAGNITNYKH POLYARIZUEMOSTEI CHASTITS. (Symmetry Relations for the Electromagnetic Particle Polarizabilities). Barashenkov, V. S.; Zaikov, R. P.; Kapustsik, E. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 5p. (In Russian). Dep. mn.

It is considered what relations between electric and magnetic polarizabilities of the baryons and mesons can be obtained in the SU_3 and SU_6 groups. In particular, it is found that two independent experiments are necessary for the determination of electric proton and neutron polarizabilities. The π^0-meson polarizabilities are expressed in terms of the matrix elements of the two-photon decays of ϕ, ω, η-resonons therefore they can be experimentally investigated. The experimental situation is briefly discussed. (auth)

4090 (N-66-21182) UNITARY SYMMETRY AND THE HIGH-ENERGY PHOTONUCLEAR REACTIONS. Lopes, J. Leite (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). Feb. 1966. 25p. (TH-129). CFSTI $3,00 cy, $0,65 mn.

A mathematical model is constructed for establishing sets of relations among the amplitudes of several photonuclear reactions which lead to the production of mesons, baryons, resonances, and hypernuclei. Matrix element relationships for single meson production in a photoproton reaction are reviewed, and the relations among the amplitudes are deduced for the photoproduction of meson pairs on proton. An example for the case of the photoproduction of three mesons on proton is also given. Some channels for the photodisintegration of helium are considered, to obtain simple amplitude relations. Amplitudes are related for the production of single mesons in the photodisintegration of the deuteron, and relations are given which correspond to the production of baryon resonances in this reaction. (STAR)

4091 CURRENT ALGEBRAS. Babu, P. (Tata Inst. of Fundamental Research, Bombay). pp 509-21 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

Commutation relations whose matrix elements are experimentally measurable are discussed in reference to the algebra generated by the space integrals of the fourth components of vector and axial vector currents, called the chiral SU(3) ⊗ SU(3) algebra. Two applications of special interest are the Adler–Weisberger derivation of the renormalization of the axial vector coupling constant of the beta decay of the neutron and the Sugawara relations for the nonleptonic hyperon decay amplitudes. (J.F.P.)

4092 MAGNETIC MOMENTS OF BARYONS IN BROKEN SU_3. Donini, E.; Pempinelli, F.; Sciuto, S. (Univ., Turin). Nuovo Cimento (10), 46A: 142-55(Nov. 1, 1966).

Sum rules for the magnetic moments of baryons are obtained by using commutators of SU_3 generators with the electromagnetic current. The calculation is performed to first order in the medium-strong breaking of SU_3. The comparison of the results with the symmetry limit shows that SU_3 is a reasonably good symmetry group. The values of Σ^+ and Λ magnetic moments are in good agreement with experimental data. (auth)

4093 CONNECTION BETWEEN CURRENT ALGEBRAS AND VECTOR-MESON POLE MODEL. Ademollo, M. (Univ., Florence. Istituto Nazionale di Fisica Nucleare, Florence). Nuovo Cimento (10), 46A: 156-61(Nov. 1, 1966).

Following the procedure by Kawarabayashi and Suzuki, in the frame of chiral $U_3 \otimes U_3$ current algebra and PCAC, the amplitude for emission of two soft pions in a p-wave is related to the electromagnetic vertex. The result is shown to be in agreement with the vector-meson pole model. The vector current amplitudes of the vector mesons are obtained in terms of the constant of the PCAC and this result is compared with that of higher symmetries. (auth)

4094 COLLINEAR U_6 SYMMETRY AND POLE MODELS FOR NONLEPTONIC HYPERON DECAYS. Venturi, G. (Univ. of Chicago). Nuovo Cimento (10), 45A: 895-904(Oct. 21, 1966). (COO-264-315; EFINS-66-28).

Nonleptonic hyperon decays are considered using the spurion scheme of broken $U_{6,6}$ symmetry directly and in connection with a pole model. In the pole model U_6 symmetry-breaking effects are taken into consideration. The model then gives the Lee-Sugawara relation without additional restrictions. (auth)

Application (Strong)

Refer also to abstract 4086.

4095 (JINR-P2-2956) STATISTICHESKAYA MODEL MNOZHESTVENNOGO OBRAZOVANIYA CHASTITS V NARUSHENNOI UNITARNOI SIMMETRII. (Statistical Model of Multiple Particle Production in Broken Unitary Symmetry). Barashenkov, V. S.; Zinov'ev, G. M.; Mal'tsev, V. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 11p. (In Russian). Dep. mn.

A statistical model with breaking unitary symmetry is proposed. The calculations are performed taking into account the splitting of the effective coupling constant which is due to difference between the interactions of the K-mesons and other particles. The results are compared with the experimental data. A noticeable disagreement is seen only in the case of the channel with small number of particles. To study them a more delicate approach is needed. (auth)

4096 PARTICLE MIXING IN POSSIBLE AXIAL VECTOR MULTIPLETS. Pundari, S. Baba; Dutta Roy, B. (Saha Inst. of Nuclear Physics, Calcutta). pp 546-7 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

The recent observation of a $K\pi\pi$ resonance, C(1270), with $I = 3/2$ and possibly $J^P = 1^+$ suggests the existence of an axial vector icoso-plet. Since there is already some evidence for axial octets, the effects of mixing among an icoso-plet and two octets, one normal ($C = -1$) and the other abnormal ($C = +1$), is considered. Mass formulas are derived. (auth)

4097 SU(3) SYMMETRY AND RELATION BETWEEN BARYONS AND LEPTONS. Tanaka, Sho (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 36: 607-26(Sept, 1966).

A hadron model is proposed on the basis of the hypothetical existence of heavy triplet leptons closely connected with the lepton family. A baryon is considered to consist of a unitary singlet boson with baryonic charge one and three triplet particles with integral electric charge and baryonic charge zero. The SU(6) symmetry is dynamically derived for the baryon by assuming a sort of atomic model. New interactions which connect these triplet particles with the lepton family are introduced in order to explain the breakdown of the SU(3) symmetry, the instability of the triplet particles and the μ-e difference in a unified way. Finally, the

importance of studying quantum electrodynamics and neutrino physics at high energies to test the hadron model is emphasized. (auth)

4098 S_4 AS A POSSIBLE INVARIANCE GROUP FOR THE FOUR FUNDAMENTAL FIELDS. Allouche, Daniel (Institut Henri Poincare, Paris). Compt. Rend., Ser. B, 665-9(Sept. 12, 1966). (In French).

The lepton-baryon symmetry suggests the existence of four fundamental baryonic fields. This model is connected with the conservation of the quantum numbers Y, I, and B, interpreted according to Sakurai's development. The invariance group is the self-representation of S_4 in which the reduction $8' gives the definition of the baryons. The mesons are obtained by the complete reduction of $\overline{8}' \times 8'$. (tr-auth)

4099 COUPLING CONSTANTS FOR 2^+ AND 1^- MESON NONETS AND THE 0^- MESON OCTET IN A MODEL WITH INFINITE MULTIPLETS. Ruehl, W. (CERN, Geneva). Nuovo Cimento (10), 46A: 115-27(Nov. 1, 1966).

The possibility of assigning 2^+ and 1^- meson resonances to states of one infinite unitary representation of the group $SL_{2,C}$ is investigated. Vertex functions are computed for the decays of these resonances into two pseudoscalar mesons or one pseudoscalar and one axial vector meson. (auth)

4100 MESON RESONANCES 2^+, 1^+, 0^+ IN THE HIGHER SYMMETRY THEORY. Chi, Cao; Nguyen van Hieu; Sredniawa, Bronislaw (Joint Inst. for Nuclear Research, Dubna, USSR). Fortschr. Phys., 14: 281-303(1966).

Mesons of spin and parity 2^+, 1^+, 0^+ in SU(6) theory and its relativistic generalizations are considered. The connection between the representations 225 and 441 of the group U(6) and the representations 4212^+ and 5940^+ is explained with the aid of the scheme GL(6). It is shown that meson resonances A_2, $K\pi$ and f_0 may belong to the representation 4212^+ as well as to 5940^+. Explicit expressions are given for the decay widths of all 2^+ mesons and the matrix elements for 1^+ and 0^+ mesons with particular values of isospin and hypercharge. (auth)

4101 OSCILLATOR-LIKE REPRESENTATIONS AND MASS FORMULAS OF U(3,3). Olszewski, Jan (Jagellonian Univ., Krakow). Acta Phys. Pol., 30: 445-75(Sept. 1966).

The investigation of U(N,N) algebras is continued by explicitly constructing the "oscillator-like" representations, defined previously of the U(3,3) algebra in a base in which the "unitary spin" SU(3) subalgebra is diagonal (as well as the isospin and hypercharge operators). This is the second simple case of U(N,N) algebras in which such a construction was possible in a completely general form owing to the existence of analytical expressions for SU(3) Clebsch-Gordan coefficients for the product $(\lambda,\mu) \otimes (1,1)$, by Kuriyan, Lurié and Macfarlane in (Journal of Mathematical Physics). The main results of previous work applied to the N = 3 case, are recapitulated, some subgroups of U(3,3) are analyzed, and the diagram of SU(3) multiplets contained in a special irreducible representation of U(3,3) is obtained. All generators of U(3,3) are represented as irreducible (singlet and octet) tensors with respect to the SU(3) subgroup which reduces the calculation of their matrix elements to a small number of reduced matrix elements according to the Eckart-Wigner theorem. After getting some reduction formulas the calculation of some special matrix elements of some components of generators is straightforward and leads to the reduced matrix elements when the corresponding SU(3) Clebsch-Gordan coefficients are taken into account. Certain possible mass formulas obtained easily when the mass operator is constructed out of the generators of U(3,3) in a definite manner are discussed. These mass formulas are some generalizations of the well-known Gell-Mann-Okubo formula. Their possible application to mesons is discussed. (auth)

4102 CONSEQUENCES OF CROSSING SYMMETRY FOR π N-SCATTERING S WAVES. Meshcheryakov, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). JETP Lett. (USSR) (Engl. Transl.), 4: 190-3(Oct. 15, 1966).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 4: 282-6(Oct. 15, 1966).

The application of crossing symmetry to the analysis of elastic πN scattering is presented. The static limit is used as an approximate expression for the principle of crossing symmetry. In this approximate expression the crossing symmetry expresses the S wave of the π^-p scattering process in terms of the S wave of the π^+p scattering process. Higher waves present a similar situation. The S phases and scattering lengths found are given. (J.F.P.)

4103 CONSISTENCY OF CHIRAL ALGEBRA APPROXIMATE SATURATION WITH EXPERIMENT. Buccella, F. (Univ., Florence); De Maria, M.; Lusignoli, M.; Taglienti, B.; Violini, G. Nuovo Cimento (10), 45A: 1050-5(Oct. 21, 1966).

The consistency of the approximate-saturation hypothesis of the $U_3 \otimes U_3$ chiral algebra with experimental data is examined by calculating the contribution from the physical resonant states. The contribution from the (56, l = 0) and (20, l = 0) states are compared with that due to other particles. (L.B.S.)

Quantum Field Theories

Refer also to abstracts 3651 and 4009.

4104 SPACE OF STATES OF RELATIVISTIC DOUBLE-POLE FIELDS. Lukierski, J. (Univ., Wroclaw). Acta Phys. Pol., 30: 487-518(Oct. 1966).

The space of states for the simplest case of relativistic multipole, double-pole field, is investigated. The analogy with free quantum electrodynamics in three (two space, one time) dimensions is pointed out. The positive metric and indefinite metric formalisms are presented. It is shown that the conventional positive metric formalism does not allow the construction of vacuum state vector with finite norm. The only admissible space of states has indefinite metric. The vacuum state has finite length and is degenerated. It is also shown that the modification of dual space by introducing a metric tensor in a way which leads to positive norms of state vectors (so-called $\tilde{\eta}$ formalism in quantum electrodynamics) breaks the translational invariance of two-point Greens functions. (auth)

4105 GENERATION OF DUAL TRANSFORMATION THROUGH FIELDS IN ELECTRODYNAMICS. Froehlich, H. (Univ. of Liverpool). Progr. Theoret. Phys. (Kyoto), 36: 636-47(Sept. 1966).

It is shown that a 4-dimensional integral in an infinitesimal region over a quantity closely connected with (H E) generates dual transformations of electromagnetic fields H, E. The generator is of a nonlocal nature and has integer eigenvalues which constitute a new property of the electromagnetic field. Generators of translations previously presented in the Yukawa memorial issue were found to require modification. They now have also the form of 4-dimensional integrals in an infinitesimal region. (auth)

4106 "QUASI-LOCAL" HEISENBERG OPERATORS AND THE PROBLEM OF RENORMALIZABILITY IN QUANTUM FIELD THEORY. Sukhanov, A. D. (Moscow Inst. of Radioelectronics and Mining Electromechanics). Zh. Eksp. Teoret. Fiz., 51: 1195-1206(Oct. 1966). (In Russian).

Explicit expressions for "current-like" operators Λ_ν and L_ν in terms of the Heisenberg field operators are obtained by combining the dynamic apparatus of the Bogolyubov, Medvedev, Polivanov axiomatics with the Lagrangian formalism apparatus in the Heisenberg representation formulated earlier. Operators Λ_ν and L_ν are not identical since they are related either to the Lagrangian or Hamiltonian of the theory. A class of theories is found for which the results obtained are the same as those which follow from the dynamic apparatus of the Lehmann–Symanzik–Zimmerman axiomatics. This class is found to be broader than the class of renormalizable (in perturbation theory) theories. (auth)

4107 SPONTANEOUS SYMMETRY-BREAKING EFFECTS IN SOME SOLUBLE FIELD-THEORETICAL MODELS. Guralnik, G. S.; Hagen, C. R. (Univ. of Rochester, N. Y.). Nuovo Cimento (10), 45A: 959-73(Oct. 21, 1966). (UR-875-139).

The problem of constructing nonrelativistic field theories which display a nontrivial spontaneous symmetry breakdown is considered within the framework of some simple soluble models. It is demonstrated by direct calculation that the formal construction of the symmetry-breaking solutions by means of an improper operator transformation is entirely equivalent to solving the equations for the Green's functions subject to a broken-symmetry condition. As an auxiliary result some useful techniques are developed for dealing with theories which do not have vacuum polarization effects. (auth)

4108 DUAL INVARIANCE IN QUANTUM ELECTRODYNAMICS. Tevikyan, R. V. (Inst. of Physics, Erevan). Zh. Eksp. Teor. Fiz., 51: 791-4(Sept. 1966). (In Russian).

The interaction between a spinor particle with electric and magnetic charges and an electromagnetic field is considered. If it be assumed that the wave function of the particle is related to the electron wave function via dual rotation, it follows that quantum electrodynamics is dually invariant. This signifies that the particle electric and magnetic charges are unobservable quantities. Experimentally only the sum of the squares of the electric and magnetic charges can be measured. If the charges are scalar then P and T parities also cannot be observed separately. Only C and PT have a physical meaning. Consequences of the assumption that an intermediate boson

possesses definite equal values of the electric and magnetic charges are considered. (auth)

4109 SIXTH-ORDER CONTRIBUTION TO Z_3 IN FINITE QUANTUM ELECTRODYNAMICS. Rosner, J. (Univ. of Washington, Seattle). Phys. Rev. Lett., 17: 1190-2(Dec. 5, 1966).

If internal photon propagators in the vacuum polarization tensor are replaced by $1/q^2$, the divergent part of Z_3^{-1} in quantum electrodynamics is

$$(Z_3^{-1})_{div} = \frac{\alpha_0}{2\pi}\left[\frac{2}{3} + \frac{\alpha_0}{2\pi} - \frac{1}{4}\left(\frac{\alpha_0}{2\pi}\right)^2\right] \ln\frac{M^2}{m^2}$$

to sixth order. The simple nature and negative sign of the last term encourage the search for a closed form for $(Z_3^{-1})_{div}$ which vanishes for $\alpha_0 > 0$. (auth)

4110 NECESSARY CONDITION FOR COMPOSITE FIELDS. Fried, H. M.; Jin, Y. S. (Brown Univ., Providence). Contract AT(30-1)-2262. Phys. Rev. Lett., 17: 1152-3(Nov. 28, 1966). (NYO-2262TA-137).

It is pointed out that there exists an elementary but rigorous argument to prove that the charge of a composite field with physical consequences indistinguishable from those of an elementary field necessarily vanishes. A composite scalar boson field composed of elementary scalar boson fields according to the Haag–Nishijima–Zimmerman construction is considered. (J.F.P.)

4111 HEURISTIC BASIS OF FIELD EQUATIONS OF FREE PARTICLES. Langbein, Werner (Physikalisches Institut, Wuerzburg, Ger.). Fortschr. Phys., 14: 259-80(1966). (In German).

The extent to which the proper field equations can be determined from physical properties of free particles (mass, spin, etc.) is investigated. The construction of space representations from free-particle states with defined momentum and spin is first treated; the transition is then made to the local covariant representation, making use of Lorentz transformations. The local covariant transformation of the field operators under space reflection is considered, and relations are obtained that lead to known field equation. The transition to the many-particle theory is then discussed. (L.B.S.)

4112 QUANTIZATION OF THE ELECTROMAGNETIC FIELD. Gallavotti, G. (Univ., Florence). Nuovo Cimento (10), 45A: 847-58(Oct. 21, 1966).

A covariant method of quantization of the electromagnetic field is proposed, which is based on the standard rules of second quantization and which leads to field operators and state vectors without any reference to indefinite metrics. (auth)

4113 RELATIVISTIC QUANTIZATION OF FIELDS. II. Takahashi, Yasushi (Dublin Inst. for Advanced Studies). Nucl. Phys., 87: 481-94(1966).

Following previous work on the relativistic quantization of fields, the transformation properties of fields are discussed and a method of constructing explicitly the wave functions for fields with arbitrary spin and nonvanishing mass is proposed. (auth)

4114 ANOMALOUS THRESHOLDS AS LIMITS OF COMPLEX SINGULARITIES. Faeldt, Goeran (State Univ. of New York, Stony Brook). Nucl. Phys., 87: 385-96(1966).

It is well-known that a vertex function $H(Z_1, Z_2, Z_3)$ satisfying certain spectral conditions may exhibit anomalous cuts. This happens e.g. when Z_1 and Z_2 are real and below their threshold values. Then $H(Z)$ is analytic in the cut Z_3-plane, but the cut may start at a value below the normal threshold value. It is shown that the anomalous part of this cut can conveniently be understood as the limit of complex singularities which approach the real axis when Z_1 and Z_2 simultaneously approach real values. In contradistinction to this, the normal static cut always is a singularity on the real axis. This phenomenon is studied for those vertex functions which can be obtained from a superposition of triangle diagrams. (auth)

4115 LINKED CLUSTER THEOREM AND THE GREEN'S FUNCTION EQUATIONS OF MOTION FOR A MANY-FERMION SYSTEM. Kobe, Donald H. (Uppsala Univ.). J. Math. Phys. (N. Y.), 7: 1806-20(Oct, 1966).

The equations of motion for the general many-time causal Green's functions for a fermion system are iterated and are shown not to lead to unlinked graphs, which is a general proof of the linked cluster theorem. An explicit expression is obtained for the perturbation expansion of an arbitrary Green's function which is applied to the one- and two-particle Green's functions. By connecting lines systematically in a set of diagrams obtained from the equations of motion, the usual topologically different linked graphs and rules are generated. (auth)

4116 REMARK ON A REDUCIBLE QUANTUM FIELD THEORY WITH A ONE-PARAMETER SYMMETRY GROUP. Lopuszanski, Jan (Univ. of Wroclaw); Reeh, Helmut. J. Math. Phys. (N. Y.), 7: 1821-3(Oct. 1966).

The connection between certain symmetry properties of a reducible algebra generated by the field operator and the decomposition into irreducible algebras is exhibited. (auth)

4117 DERIVATION OF CANONICAL FIRST-ORDER FIELD EQUATIONS. Brulin, O.; Hjalmars, S. (Royal Inst. of Tech., Stockholm). Ark. Fys., 32: 569-74(1966).

Volterra's procedure of constructing canonical first-order field equations is modified so as to include such symmetrical forms of the Lagrangian for which the original procedure does not work. The modified procedure is applied to common linear tensor field theories. (auth)

4118 DOUBLY LOGARITHMIC ASYMPTOTIC EXPRESSION IN QUANTUM ELECTRODYNAMICS. Gorshkov, V. G.; Gribov, V. N.; Lipatov, L. N.; Frolov, G. V. (Ioffe Inst. of Physics and Tech., Leningrad). JETP Lett. (USSR) (Engl. Transl.), 4: 215-18(Oct. 15, 1966).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 4: 321-5(Oct. 15, 1966).

The possible doubly logarithmic asymptotic expressions for four-point diagrams in quantum electrodynamics are considered. All processes are classified with respect to the charge propagating in the intermediate state of the t channel. (J.F.P.)

4119 GREEN FUNCTIONS IN THE QUANTUM FIELD THEORY AND IN QUANTUM STATISTICS. Fradkin, E. S. Tr. Fiz. Inst., Akad. Nauk SSSR, 29: 7-138(1965). (In Russian).

Several questions are discussed on the application of the method of Green's functions to quantum field theory. The related work of the author on quantum statistics is discussed in detail. A set of Green time-functions is derived and the energy spectra of systems of particles are calculated. A system of quantum statistic equations is then derived for the case when the temperature equals zero. In this case, a system of equations in Euclidean four-dimensional momentum-space evolves from the Green functions in quantum statistics, which is equivalent to the conventional field theory in vacuum ($T = 0$, $\mu = 0$) or in a medium ($T = 0$, $\mu \neq 0$). This system of equations is derived; and its bases are established, using conventional field theory, by calculating (by way of example) the polarization and the mass operators in mesodynamics and in electrodynamics in a medium and in a vacuum. The formulation of the theory in Euclidean variables has to consider a series of cases primarily through computation because the momentum space is Euclidean. The inverse operators in Green functions do not have zeros, therefore their division is one-dimensional. It is further found that the imaginary parts of the Green functions are zero and they appear only in transitions to the pseudo-Euclidean variables. 77 references. (G.O.Y.)

4120 INTERACTIONS BETWEEN SPINOR AND ELECTROMAGNETIC FIELDS. Efimov, Z. F. Vestn. Moskov. Univ., Ser. III: Fiz. Astron, No. 4, 7-12(July–Aug. 1965). (In Russian).

The Lagrange formalism of the theory of local interactions of spinor fields with electromagnetic fields makes it possible to describe the systems examined and to obtain physically actual results only under conditions when, as wave functions, characterizing the state of the system, the functions can not guard against free but interacting fields. With this rule of preservation of the dynamic fields, the magnitudes were realized only for all systems altogether, but not for every system from interacting fields. (tr-auth)

4121 METHODS OF THE THEORY OF FUNCTIONS OF MANY COMPLEX VARIABLES. Vladimirov, Vasiliy Sergeyevich. Cambridge, Mass., The M.I.T. Press, 1966. 362p. $12.00.

Translation by Scripta Technica, Inc., of Metody Teorii Funktsiy Mnogikh Kompleksnykh Peremennykh, edited by Leon Ehrenpreis.

A systematic exposition of the fundamentals of the theory of single sheeted domains of holomorphy and its applications to quantum field theory, to the theory of functions, and to differential equations with constant coefficients is presented. (B.G.D.)

Scattering Theory

Refer also to abstracts 3632 and 3960.

4122 (CALT-68-106) NEW EXPERIMENTAL EVIDENCE ON REGGE POLES IN HIGH ENERGY SCATTERING. Frautschi, Steven C. (California Inst. of Tech., Pasadena). Sept. 1966. Contract AT(11-1)-68. 21p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The earliest high-energy experiments to be analyzed with Regge poles were measurements of total cross sections and diffraction peaks. The analysis involved many parameters because: many Regge poles could be exchanged in these processes; and the variation of Regge couplings with momentum transfer t could not be predicted even for a single exchange. Because of the large numbers of parameters, the fits obtained were not convincing. More recently, measurements of smaller high-energy cross sections, involving charge exchange, baryon exchange, and so forth have become available. Some of these provide cleaner tests of Regge pole theory, with fewer parameters. However, it was noticed that although the t dependence of couplings could not be predicted, the couplings sometimes predict zeros when α passes through integers or half integers in the Regge formula $d\sigma/dt(s,t) = f(t)s^{2\alpha_\rho(t)-2}$. The coupling zeros are classified into two types, signature zeros and nonsense zeros, and they are discussed. (B.G.D.)

4123 (JINR-E2-2932) ANALYTICITY, LOCALITY, AND SYMMETRY WITH INFINITE MULTIPLETS. Dao Vong Duc; Nguyen Van Hieu (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 17p. Dep. mn.

The analytical properties of scattering amplitudes are studied in the framework of symmetry theory with infinite multiplets. For simplicity the group SL(2,c) is chosen as internal symmetry group. The relation between symmetry theory with infinite multiplets and quantum field theory is also considered. It is shown that the requirement of symmetry is incompatible with the usual local property of interacting fields. (auth)

4124 R-MATRIX THEORY OF REGGE POLES. Roskies, Ralph (Yale Univ., New Haven). Ann. Phys. (N. Y.), 40: 197-220(Nov. 1966).

The techniques of Wigner's R-matrix formalism are used to study the properties of Regge poles in both the single and the many channel case. (auth)

4125 ON THE CONNECTION BETWEEN THE ZEROS OF THE AMPLITUDE NEAR t = 0 AND THE SLOPE OF THE DIFFRACTION PEAK. Bessis, J. D. (CERN, Geneva). Nuovo Cimento (10), 45A: 974-82(Oct. 21, 1966).

Using only axiomatic field theory, it is shown that the absorptive part of the amplitude $A_2(s,t)$ has no zeros inside the circle $|t| \leq t_1 \equiv (2\pi/15e)^2\mu^2(\log(s/s_0))^{-2}$ for $s > s_0$. It is then shown that the quantity $\frac{1}{2}\alpha_1' \equiv (d/dt)\log A_2(s,t)|_{t=0}$ has the property $0 \leq \frac{1}{2}\alpha_1' \leq e(15/\pi\mu)^2(\log(s/s_0))^2$. These bounds are the best that can be obtained using only analyticity in one complex variable, because it is shown that improving t_1, for instance, improves the Froissart bound. In particular it is shown that if the amplitude does not become purely real for large physical energies the slope of the diffraction peak $(d/dt)\log(d\sigma/d\Omega)|_{t=0}$ increases at most as $(\log s)^2$, the Regge hypothesis giving log s. (auth)

4126 V-θ SECTOR OF THE LEE MODEL. II. EIGENPHASESHIFTS AND LEVINSON'S THEOREM. Bronzan, J. B. (Massachusetts Inst. of Tech., Cambridge); Cassandro, M.; Vaughn, M. T. Contract AT(30-1)-2098. Nuovo Cimento (10), 46A: 128-41(Nov. 1, 1966). (MIT-2098-238).

The spectrum of the S-matrix in the V-θ sector of the Lee model is analyzed. It consists, at fixed total energy, of a continuous spectrum identical with that of the disconnected S-matrix, together with a possible discrete spectrum consisting of the roots of a certain transcendental equation. This equation may have zero, one, or two roots, depending on circumstances. If at least one root exists, at all physical energies, the eigenphaseshift which joins continuously to the V-θ elastic-scattering phase shift below production threshold satisfies a Levinson theorem. The phase of the determinant of the connected S-matrix, as defined by Wright, is shown to satisfy a Levinson theorem. The situation when no stable V-particle exists is also analyzed. Here the phase of the determinant of the connected S-matrix does not satisfy a Levinson theorem, but a more general result is not obtained. (auth)

4127 POSSIBLE INSTABILITY OF PARTIAL-WAVE AMPLITUDES WITH RESPECT TO THE LEFT-HAND DISCONTINUITY. Auberson, G.; Wanders, G. (Univ., Lausanne, Switzerland). Nuovo Cimento (10), 46A: 77-88(Nov. 1, 1966).

Nonrelativistic, purely elastic S- and P-wave two-pole models are discussed. The location of the poles of the partial-wave amplitudes is studied as a function of the input parameters. Some values of these parameters lead to unphysical results. The amplitudes are instable with respect to the input parameters for critical values of these parameters. (auth)

4128 SUPERCONVERGENCE RELATIONS FOR ARBITRARY SPIN. Trueman, T. L. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 17: 1198-1200(Dec. 5, 1966).

It is shown how to generalize the recent suggestion of de Alfaro, Fubini, Rossetti, and Furlan to arbitrary spin in a simple way. (auth)

4129 HIGH-ENERGY CONSISTENCY CONDITIONS FOR PARTIAL-WAVE SCATTERING AMPLITUDES. Kugler, M. (Rockefeller Univ., New York). Phys. Rev. Lett., 17: 1166-9 (Nov. 28, 1966).

Superconvergence sum rules are constructed for partial-wave scattering amplitudes. $\pi\pi$ scattering is discussed. (auth)

4130 DOUBLE-LOGARITHMIC ASYMPTOTIC FORM OF THE COMPTON EFFECT FOR LARGE ANGLE SCATTERING. Gorshkov, V. G.; Gribov, V. N.; Frolov, G. V. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teoret. Fiz., 51: 1093-1106(Oct, 1966). (In Russian).

The asymptotic form of the Compton effect is obtained in the double-logarithmic approximation for scattering into large angles. Calculation of the asymptotic values is performed by summation of the asymptotic contribution of the Feynman graphs. It is demonstrated that graphs both containing and not containing infrared divergences are important. The asymptotic behavior of the amplitude can be described by the formula $\exp\{-\alpha(4\pi)^{-1}\ln^2(s/m^2)\}$. The asymptotic behavior of the cross section is found for various ways of measuring the accompanying bremsstrahlung radiation. The total cross section for elastic scattering and bremsstrahlung without any restriction on the bremsstrahlung quantum energy does not contain doubly logarithmic terms and is equal to the asymptotic value of the Klein-Nishina-Tamm cross section. (auth)

4131 VARIATION OF GREEN'S FUNCTIONS. Devooght, J. (Univ. Libre, Brussels). J. Math. Phys. (N. Y.), 7: 1764-70 (Oct. 1966).

The variation of the Green's function of a linear differential operator is computed as the variation of an n-tuple integral with variable boundary. This generalization of Hadamard formula is shown to lead naturally to the method of invariant embedding of Bellman. Three applications of the general formalism are given: the Dirichlet problem, the neutron or photon transport in a plane parallel anisotropically scattering slab, and scattering in a central field where three identities used in potential scattering are shown to be a consequence of the invariance of the asymptotic Green's function. (auth)

4132 KINEMATICS OF MULTIPARTICLE PROCESSES. Jacobson, D. A. (Douglas Advanced Research Lab., Huntington Beach, Calif.). Nuovo Cimento (10), 45A: 905-23(Oct. 21, 1966).

A thorough analysis is made of the kinematics of a general scattering process involving N particles. The following structural properties are proved for the physical region: (1) The physical regions for individual channels are connected and mutually disjoint. (2) The entire physical region can be decomposed into a sum of three real analytic manifolds of dimension 3N - 10, 2N - 6, and N - 3, plus a finite set of points. (3) The physical region can be imbedded in a connected (3N - 10)-dimensional analytic set, which in turn can be decomposed into a sum of three complex analytic manifolds of dimension 3N - 10, 2N - 6, and N - 3, plus a finite set of points. (auth)

4133 FORMAL EXPRESSION OF THE S-MATRIX FOR SCATTERING FROM REPULSIVE SINGULAR POTENTIALS. Spector, R. M. (Wayne State Univ., Detroit). Nuovo Cimento (10), 45A: 924-9(Oct. 21, 1966).

For potentials which are repulsive and more singular than r^{-3} at the origin, a formal expression for the S-matrix for any angular momentum is derived. The expression is in terms of an integral over the wave function for the problem which is finite at the origin. Expressions for Jost functions are also given which are unique up to a specified multiplicative function of k. (auth)

4134 PROPERTIES OF BOUND STATES AND REGGE POLES DERIVABLE FROM MODIFIED WRONSKIAN RELATIONS. Calogero, F. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome); Cosenza, G. Nuovo Cimento (10), 45A: 867-81 (Oct. 21, 1966).

Equations which connect the energies and angular momenta of bound states with appropriate integrals over the bound-state wave functions are obtained applying a modified Wronskian-type technique to the radial Schrödinger equation. From these equations simple restrictions on the energies and angular momenta of bound states are derived. A remarkably simple result is the following upper limit for the angular momentum of bound states in the potential V(r): $\hbar^2 l(l+1) < 2m \operatorname{Max}[\frac{1}{2} r^3\, dV(r)/dr]$. The results which obtain applying these techniques to Regge poles are also analyzed. (auth)

4135 ASYMPTOTIC BEHAVIOR OF PRODUCTION AMPLITUDES IN PERTURBATION THEORY: 6-POINT PRODUCTION

GRAPHS. Leoni, F. (Univ., Rome). Nuovo Cimento (10), 45A: 813-29(Oct. 21, 1966).

A study is made of the production amplitudes asymptotic behavior in perturbation theory for scalar particles in $\lambda\varphi^3$ topology when the number of the external lines is 6. The choice of independent invariants is complicated by a geometric equation expressed by the annihilation of a Grammian. An asymptotic solution is given in some particular cases (quasi-elastic processes). Some Eden's and Tiktopoulos' theorems about C and D properties are generalized. The calculation is performed for energies going to infinity and momentum transfers small and fixed. This can be considered a particular way to approach the multiperipheral model. The two methods of λ-transform and Mellin transform are used. In some cases a Regge asymptotic behavior was found. (auth)

4136 ASYMPTOTIC BEHAVIOR OF A DIRAC PARTICLE IN A COULOMB FIELD. Dollard, J.; Velo, G. (Palmer Physics Lab., Princeton, N. J.). Nuovo Cimento (10), 45A: 801-12 (Oct. 21, 1966).

The asymptotic form for the wave-function of a spin-½ particle scattered by a Coulomb potential is discussed. A convergence theorem is proved establishing the existence of a generalized Møller wave-matrix. Problems remaining in the theory are mentioned. (auth)

Particle Accelerators

Refer also to abstracts 3245 and 3470.

4137 (AECL-2614) STRUCTURE OF A BUNCH OF CHARGE IN AN IDEAL ACCELERATOR. Newton, T. D. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). July 1966. 66p. (FSD-ING-53). Dep. mn. AECL $1.50.

A bunch of charged particles is considered to be moving in a long conducting tube subject to external time-independent focusing forces. The density of particles in the bunch and the electromagnetic field of the bunch of charge in the conducting tube are simultaneously determined. The parameters of the idealized accelerator may be obtained from those of an actual machine design so that predictions of bunch shape and effects of space and image charges on phase areas (emittances) may be made. (auth)

4138 (AWRE-O-53/66) ION BUNCHING SYSTEM FOR THE 6 mV VAN de GRAAFF ACCELERATOR. Anderson, J. H. (Atomic Weapons Research Establishment, Aldermaston (England)). Oct. 1966. 43p. Dep. BIS $1.20, HMSO 6s.

A radio frequency chopping and a klystron type of bunching system is described for the generation of short-duration ion bursts in which the bunching and chopping equipment is incorporated in the top terminal of a 6 MV Van de Graaff accelerator. A method for setting up and monitoring the beam burst width is also described. Test bench measurements on the bunching system indicate ion burst durations for H_1^+, H_2^+, H_3^+ beams of less than 1 ns at half height with peak current gain factors of greater than 4:1. Electronic and time-of-flight measurements carried out after installation indicate the beam burst duration to be less than 1.5 ns at target for protons and deuterons. A mean pulsed beam current of 10 μA on target compares with 1 μA previously obtainable using the top terminal flapping method for pulsing. (auth)

4139 (BNL-10487) PARTICLE ACCELERATORS. Buchanan, V. J.; Grand, P.; Lasky, C. (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract AT-30-2-GEN-16. 37p. (CONF-661102-7). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From American Society of Mechanical Engineers, Winter Annual Conference, New York.

A classification and brief discussion of the major types of particle accelerators in common use today are presented. The 33 BeV Alternating Gradient Synchrotron is then described in terms of its specific engineering problems. Finally, the proposed modifications of the 33 BeV synchrotron to increase its beam intensity are described. (auth)

4140 (BNL-10651) BROOKHAVEN'S RECENT PREACCELERATOR PROGRESS. Sluyters, Th. J. M. (Brookhaven National Lab., Upton, N. Y.). Sept. 29, 1966. Contract AT(30-2)-Gen-16. 18p. (CONF-661021-18). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Linear Accelerator Conference, Los Alamos, N. Mex.

The new BNL linac preaccelerator is discussed in two sections: the ion source and beam performances measured at extractor voltage (~40 kV); and the accelerating tube, high voltage behavior and beam performances measured at 750 kV. (B.G.D.)

4141 (JINR-E13-2926) EFFECTIVE RESOLVING TIME IN COINCIDENCE MEASUREMENTS ON THE CYCLOTRON BEAM. Khrynkevich, A. Z.; Kopta, S.; Shimchik, S.; Val'chak, T. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1966. 17p. Dep. mn.

The influence of the hf pulsation of the cyclotron beam and of its modulation caused by the duty cycle on the resolving time in coincidence measurements is taken into account. Formulas for the effective resolving time in gamma-gamma, gamma-particle, and particle-particle coincidence measurements for different ratios of the electronic resolving time to the width of hf bunches and to their repetition period are given. It is shown that the delayed chance coincidence curve can be used for the determination of the cyclotron bunch width. This conclusion was checked by a measurement performed on the beam of the heavy ion cyclotron of the JINR in Dubna. (auth)

4142 (JINR-P-2912) OGRANICHENIE TOKA PUCHKA PROSTRANSTVENNYM ZARYADOM V SINKHROTSIKLOTRONE OIYAI. (Restriction of the Beam Current by Space Charge in the JINR Synchrocyclotron). Danilov, V. I.; Puzynin, I. V.; Safonov, A. N.; Feoktistov, B. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1966. 33p. (In Russian). Dep. mn.

The size of the beam at the beginning of acceleration for the synchrocyclotron and the Coulomb force components of the beam are calculated. Critical currents are found which are held in the beam by all the focusing forces and can be accelerated at the dee voltage 18 kV. (auth)

4143 (LYCEN-6627) APPLICATION DE LA METHODE DES PERTURBATIONS A LA MESURE DU CHAMP ELECTROMAGNETIQUE DANS DES CAVITES RESONNANTES. REALISATION D'UN BANC DE MESURES. (Application of Perturbation Method for Measuring Electromagnetic Field in Resonant Cavities. Realization of an Experimental Setup). Voisin, Gilles (Lyon Univ. (France). Institut de Physique Nucleaire). July 5, 1966. 78p. Dep. mn.

Thesis.

The development of a set of procedures for measuring the electromagnetic field in resonant cavities based on the perturbation method is described. The perturbation method reduces the determination of fields to measurements of frequency variations caused by the introduction of perturbing objects in the interior of the area studied. The general formulas are derived in an original manner and practical applications are deduced. The experimental setup is described. The principles of its design are given, and its various elements are analyzed. The performances obtained are described. A comparative study is made of different forms of usable perturbing objects. Some experimental results obtained are reported. (J.S.R.)

4144 (ORNL-TM-364) OPERATIONAL SAFETY AND RADIATION PROTECTION FOR THE OAK RIDGE ISOCHRONOUS CYCLOTRON. Russell, J. A. Jr.; Jones, R. J. (Oak Ridge National Lab., Tenn.). Oct. 1962. Revised Oct. 1966. Contract W-7405-eng-26. 16p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Two independent systems for providing operational safety and radiation protection for personnel at the Oak Ridge Isochronous Cyclotron are described in detail. A radiation alarm system monitors all hazardous areas. The cyclotron and all beam-use areas are operated completely by remote control; a complex system of interlocks and operation controls prevent access to any hazardous area while the cyclotron is in operation. This system is designed so that at least three interlocks must fail and both the person entering the room and the operator must make misjudgments before a radiation exposure can occur. In four years of cyclotron operation the systems have proved fully reliable and operationally very satisfactory. (auth)

4145 (RHEL/R-120) ELECTROSTATIC GENERATOR GROUP. Final Report. Allen, W. D.; Dawton, R. H. V. M. (Rutherford High Energy Lab., Chilton (England)). Sept. 1966. 74p. Dep. mn. BIS $3.00; HMSO 15s. 0d.

The progress report written in 1962 and 1963 on the Oxford Electrostatic Generator Project is completed with a description of the performance of the injector as a whole and of operation coupled with a tandem. (B.G.D.)

4146 (SLAC-PUB-218) COMPUTER STUDY OF WAVE PROPAGATION BEAM LOADING AND BEAM BLOWUP IN THE SLAC ACCELERATOR. Helm, R. (Stanford Linear Accelerator Center, Calif.). Oct. 1966. Contract AT(04-3)-400. 29p. (CONF-661021-19). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Linear Accelerator Conference, Los Alamos, N. Mex.

A study of wave propagation beam loading and beam blowup was undertaken using the coupled-resonator model of wave propagation and the development of a computer program for its solution. The computer program was capable of simulating both the single-cavity and the coupled-resonator models of beam blowup. (B.G.D.)

4147 (SLAC-PUB-219) INITIAL OPERATING EXPERIENCE AND PERFORMANCE OF THE SLAC ACCELERATOR. Neal, R. B. (Stanford Linear Accelerator Center, Calif.).

Oct. 1966. Contract AT(04-3)-400. 47p. (CONF-661021-21). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Linear Accelerator Conference, Los Alamos, N. Mex.

A brief review of the final design configuration of the accelerator, its principal components, and initial operating results are presented. Topics included are general description, accelerator housing and klystron gallery, accelerator structure and support girder, high power klystrons, beam switchyard, beam switchyard instrumentation, and research areas. (B.G.D.)

4148 (SLAC-PUB-228) KLYSTRONS FOR THE STANFORD LINEAR ACCELERATOR CENTER. Merdinian, George K.; Lebacqz, J. V.; Bierce, R. W. (Stanford Linear Accelerator Center, Calif.). Oct. 1966. Contract AT(04-3)-400. 21p. (CONF-661028-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From International Electron Devices Meeting, Washington, D. C.

A brief review is presented on the design and performance of the klystrons for the Stanford Linear Accelerator including the mean value of measured power output and an analysis of the information available to date on tube life. (B.G.D.)

4149 (UCRL-16806, pp 58-9) FURTHER IMPROVEMENTS ON THE 10-kV ION ACCELERATOR. Pohlit, Helmut M.; Erwin, Wallace R. (California Univ., Berkeley. Lawrence Radiation Lab.).

Improvements in the power supply of a 10 kV carbon-ion accelerator are reported. The object of changes was to obtain a particle beam of less than 100 eV. (C.H.)

4150 (UCRL-17001) MEASUREMENTS OF THE LINEAR-ACCELERATOR EXIT BEAM OF THE BEVATRON INJECTOR. Allison, Robert W. Jr.; Evans, Don M.; Richter, Robert M.; Sherwood, Allen J.; Zajec, Emery (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 19, 1966. Contract W-7405-eng-48. 44p. (CONF-661021-20). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Linear Accelerator Conference, Los Alamos, N. Mex.

A series of measurements of the characteristics of the linear accelerator (linac) exit beam were made to determine if variations in beam position, emittance, and energy spread were present. These measurements show that beam position movements due to voltage ripple on the preinjector and linac rf systems occur. Positions were measured with a resonant 200-MHz induction electrode which detects the center of gravity of the beam. In addition, a series of momentum measurements were made to study filamentation of the linac beam, and the effect of the prebuncher and debuncher. A correlation was obtained between energy ripple and the beam position jitter. An emittance device that uses a sweeping magnetic field for measuring emittance was constructed, and a preliminary study was made of the linac emittance variation with intensity and tank gradient. (auth)

4151 (UCRL-17018) A 1.2-1.9 BeV/c, SEPARATED K^- MESON BEAM: DESIGN AND CONSTRUCTION. Button-Shafer, Janice; Kalbfleisch, George R.; Miller, Donald H.; Kirz, Janos; Wohl, Charles G.; Hubbard, J. Richard; Huwe, Darrell O.; Ticho, Harold K.; Stork, Donald H. (California Univ., Berkeley. Lawrence Radiation Lab.). July 28, 1966. Contract W-7405-eng-48. 44p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The design and operation of a variable-momentum, separated K^- meson beam for an experiment in the 72-inch hydrogen bubble chamber at the Bevatron are described. The beam momentum was variable over the region 1.25 to 1.95 BeV/c. With two stages of electromagnetic separation, the beam channel measured 155 ft (target to bubble chamber); it afforded a pion rejection factor of about 10^5. The K^- meson flux at the chamber was about 10 K^- per 10^{11} protons at the higher momenta, and somewhat less at the lower. Beam contamination (by pions and muons) was ≤10 percent. A total exposure of about 14,000 events per millibarn was made. (auth)

4152 (UCRL-17111) HIGH-DUTY-FACTOR CONVERSION OF THE BERKELEY HILAC. Smith, Bob H. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 19, 1966. Contract W-7405-eng-48. 9p. (CONF-661021-22). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Linear Accelerator Conference, Los Alamos, N. Mex.

A 6-MW dc power supply and a hard-tube modulator system was installed at the Hilac to supply the anode power for the oscillators of the two linear accelerators. The pulse repetition rate and pulse width are variable. Most bombardments use a repetition rate of 40 pulses per second and pulse widths between 2 and 8 msec. The rf system and ion-source equipment were modified to handle the increased average power. Additional water cooling was applied to the linac tanks. The coupling line between the two tanks was removed and an electronic phase regulating system was installed. Improved rf amplitude regulators were developed and installed. Another RCA type-6949 tube was added to the poststripper tank. The rf system now consists of five type-6949 tubes, four of which are self-excited oscillators and one a driven amplifier. The latter serves as a pre-exciter and also keeps the self-excited oscillators on the correct tank mode. The prestripper is excited by an RCA-6949 in a drive amplifier circuit. (auth)

4153 (UCRL-17124) ENERGY RESOLUTION IN CYCLOTRON EXPERIMENTS. Moss, Joel; Ball, Gordon C. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1966. Contract W-7405-eng-48. 36p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An analysis was made of the factors affecting energy resolution in experiments carried out at the Berkeley 88 in. cyclotron. The contributions from various sources are treated individually and a method of combining these effects to obtain the total theoretical energy resolution is discussed. Good agreement was obtained when the theoretical calculations were compared with experimental results. (auth)

4154 (UCRL-17130) MEASUREMENTS ON A MODEL RF MANIFOLD SYSTEM. Voelker, Ferdinand (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 16, 1966. Contract W-7405-eng-48. 18p. (CONF-661021-23). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Linear Accelerator Conference, Los Alamos, N. Mex.

A one-tenth-scale rf manifold system with six cavity loads and several amplifiers operating at 200 MHz was set up. The manifold is a 50-ft-long coaxial line, and the cavities are foreshortened quarter-wave resonators with about 25 higher-order resonances below 2GHz. The measurement program consists of three parts. The first part consists of steady-state measurements of amplitude and phase along the system in the principal pass band. The second part consists of measurements during the rise and fall time in pulsed operation. The third part consists of measurement of higher-order modes of the system which are excited by very short pulses of current (~0.25 nsec) in the gaps of the cavities. (auth)

4155 INVESTIGATION OF THE RADIAL SECTOR-TYPE FFAG-ELECTRON SYNCHROTRON (MAXIMUM ENERGY OF 150 MeV). II. NUMERICAL STUDY OF PARTICLE MOTION AND OVERLAPPING OF SELECTED PARAMETERS. Heinz, W. (Freie Univ., Berlin). Nucl. Instrum. Methods, 45: 197-220 (1966). (In German).

The various parameters and characteristics of a FFAG-accelerator with a maximum energy of about 150 MeV and their mutual dependences are studied using manifold numerical calculations. Among others the equilibrium orbit, the circumference factor, the orbit stability, the radiation loss, the betatron amplitudes at injection and during acceleration are investigated. The main influence on the circumference factor and betatron frequencies gives g_0/g_1 (g_n Fourier coefficients of the magnetic guide field), both the circumference factor and betatron frequencies strongly decrease with increasing g_0/g_1. With decreasing g_2/g_1 or g_3/g_1, C decreases but ν_x and ν_z increase. Higher Fourier coefficients only influence the circumference factor, but leave unaltered ν_x and ν_z. The single effects superpose without essential disturbance. Small angular spread of the beam at injection gives small betatron amplitudes, whilst radial spread is of minor influence. Radiation loss limits the maximum permissible storage time and gives an upper limit for the possible end energy. There exist possible stable operation points for N = 12 to 16; $k \approx 10$, $r_e = 300$ cm, end energy 150 MeV. The tolerances for the magnetic guide field and the permissible energy spread are evaluated. Some considerations of rf acceleration especially with regard to injection problems are made: increasing the intensity, enlargement of the duty factor (up to 1), fixing the energy and energy spread. (auth)

4156 ENERGY ACCUMULATION OF HEAVY IONS BY MULTIPLE TRAVERSAL THROUGH A SINGLE TANDEM ACCELERATOR. Hortig, G. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Instrum. Methods, 45: 347-8(1966).

A heavy ion accelerator is proposed which utilizes an electrostatic field to accelerate the ions thereby taking advantage of the difference between the most probable charge acquired by the ions in gaseous and solid targets. The feasibility of such an accelerator is demonstrated by use of a tandem accelerator. (B.G.D.)

4157 BIASED QUADRUPOLE: A METHOD OF STEERING ACCELERATOR BEAMS. Cramer, J. G.; Schmidt, F. H. (Univ. of Washington, Seattle). Contract AT(45-1)-1388. Nucl. Instrum. Methods, 45: 325-7(1966). (RLO-1388-8).

A simple technique for steering accelerator beams using a biased quadrupole is presented. This technique incorporates altering the effective position of the quadrupole electrically by systematically unbalancing the current through its coils. (B.G.D.)

4158 STEADY-STATE ACCELERATION OF PARTICLES IN THE PRESENCE OF SPACE CHARGE. Lebedev, A. N.; Zhilkov, E. A. (Lebedev Inst. of Physics, Moscow). Nucl. Instrum. Methods, 45: 238-44(1966).

The phase motion in cyclic accelerators in the presence of a proper field of a bunch is investigated. Self-consistent stationary distributions of the density and the corresponding distributions of the potential are determined. A general expression for the charge limit is obtained, which does not depend on the distribution of particles in the phase plane. It is shown that even in the absence of an external rf field it is possible to have a steady self-phased state due to the action of the proper field. (auth)

4159 THE 140-MeV ELECTRON SYNCHROTRON OF THE PTB. II. CALCULATION OF THE EDGE CORRECTION TO THE POLE PROFILE AND MEASUREMENT OF THE FIELD GRADIENT. Auch, K.; Reich, H.; Trier, J. O. (Physikalisch-Technische Bundesanstalt, Brunswick). Z. Angew. Phys., 21: 486-92(1966). (In German).

Hardt's method of calculating the shape of the shimming rim of a strong focusing synchrotron magnet by conformal mapping is reviewed and extended on a weak focusing synchrotron with field index n = 2/3. Fitting three constants gives first and second order corrections to the pole profile, and takes into account a prescribed peak value of the induction at the pole surface in order to avoid saturation. On measuring the radial dependence of the field gradient at the PTB-synchrotron by means of two peaking strips or two field coils in a bridge circuit it was found, that the exactness achieved by former authors can be reached in a simpler way by using a device for interchanging the probe positions. For the measurement of the azimuthal dependence at the central orbit a very simple method was developed with the aid of a commercial Hall effect gaussmeter with internal zero suppression: instead of the one probe provided by the manufacturer two probes were inserted, and the difference of the Hall-voltages produced by them was lead to the amplifier input. This method gives a relative value of the field index with an accuracy of better than 0.1%. (auth)

4160 A NON-INTERCEPTING BEAM POSITION, BEAM CURRENT, AND PULSE SHAPE MONITOR FOR PULSED ACCELERATORS. Bogaards, J. J. W. Jr.; Drake, T. E. (Univ. of Saskatchewan, Saskatoon). Nucl. Instrum. Methods, 42: 297-8(July 1966).

The configuration and performance of a monitor which uses the electric field of the beam as the source of information are described. The monitor is designed to yield information about the beam position, beam current, and beam pulse shape. With the appropriate electronics this information can be obtained for peak currents as low as 0.1 mA and pulse lengths of a few nsec. (B.G.D.)

4161 COMPARISON OF ION SOURCE PERFORMANCE ON A PULSED TANDEM VAN DE GRAAFF. Collins, L. E.; Dandy, D.; Stroud, P. T. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Nucl. Instrum. Methods, 42: 206-10(July 1966).

The pulsed performance of the AWRE tandem Van de Graaff with klystron bunching was investigated for H^- ions. Comparison figures are given for four types of ion source. The pulse widths are shown to be limited by the ion source energy spread and the causes of the spread are discussed. (auth)

4162 METHODS FOR THE EXTRACTION OF PARTICLE BEAMS FROM SYNCHROTRONS. Bizzarri, U.; Letardi, T.; Turrin, A. Comit. Naz. Energ. Nucl., Notiz., 12: No. 10, 27-32(Oct. 1966). (In Italian).

A general view is made of all operating techniques being developed on synchrotrons with a view to making them increasingly efficient sources of high-energy particles. The work done so far in this direction at the Frascati National Laboratories on the 1.1 GeV electrosynchrotron is also discussed. (auth)

4163 DIRECTIONAL BEAM VALUE OF PLASMA ELECTRON SOURCE. Munakata, C. (Hitachi Ltd., Tokyo). Nucl. Instrum. Methods, 42: 291-2(July 1966). (In German).

A formula according to Langmuir is given for the maximum directional beam value of an electron gun, which is shown to be dependent on the current density of the source. It is pointed out that a higher maximum directional beam value or modified current density can be obtained by a plasma-electron source than by the normal electron gun with a tungsten cathode. Calculations are presented for the modified current density of the plasma and of the tungsten as a function of temperature. (L.B.S.)

4164 DESCRIPTION OF A SOURCE OF POLARIZED NEGATIVE HYDROGEN OR DEUTERIUM IONS BASED ON THE PROPERTIES OF THE $2S_{\frac{1}{2}}$ METASTABLE STATE: THEORY AND EXPERIMENTS. Cesati, A.; Cristofori, F.; Colli, L. Milazzo; Sona, P. G. (CISE, Milan. Univ., Milan). Energ. Nucl. (Milan), 13: 649-67(Dec. 1966).

A general description of the method to obtain a source of polarized negative ions by means of the properties of the $2S_{\frac{1}{2}}$ metastable state of hydrogen atom is given. Particular evidence is devoted to the experimental work which preceded the realization of the source, namely the charge exchange processes to obtain an intense beam of metastable atoms and to ionize them. The theoretical considerations on which the method is based are recalled and the description of the experimental apparatus and the experimental results is given. (auth)

4165 SPHERICAL ABERRATION OF AN ELECTROMAGNETIC QUADRUPOLE DOUBLET. Dymnikov, A. D.; Fishkova, T. Ya.; Ovsyannikova, L. P.; Yavor, S. Ya. (Ioffe Inst. of Physics and Tech., Leningrad). Nucl. Instrum. Methods, 42: 293-6 (July 1966).

For focusing charged particles with quadrupole lenses a system of quadrupole lenses with oppositely directed fields is most commonly used. In order to calculate the aberrations of such a doublet one has to determine the aberrations of the composing lenses. Spherical aberration of a quadrupole lens with a stigmatic beam falling on it were given previously. After the beam passes through the first lens it becomes astigmatic. The calculation of .he aberrations of the second lens is presented. (B.G.D.)

4166 INVESTIGATIONS FOR A FFAG ELECTRON SYNCHROTRON OF THE RADIAL SECTOR TYPE (END ENERGY OF 150 MeV). I. GENERAL REVIEW AND THEORETICAL PRINCIPLES. Heinz, W. (Freie Univ., Berlin). Nucl. Instrum. Methods, 45: 102-18(Nov.-Dec. 1966). (In German).

The first of a series of publications is presented giving results of theoretical and experimental investigations for designing a FFAG-accelerator. A general survey and the features of the theory for the publications to follow are included. The survey treats the principle, the advantages of, and possibilities with such an accelerator and some of the experiments that make it desirable to have a FFAG-accelerator. The theory of motion and acceleration of particles in a FFAG-accelerator is presented in a form suitable to the special problems under consideration. It is started with the motion of an electron in an electromagnetic field without considering acceleration, field errors, radiation loss and particle-particle interaction. The differential equations for the equilibrium orbit and betatron frequencies are given in the Hamiltonian form particularly adapted to numerical evaluations. Then expressions respecting field errors in FFAG accelerators are derived. A general Hamiltonian and the essential results of the motion of accelerated particles are presented. The radiation loss of circulating electrons is calculated. Besides the known dependence upon energy and radius there exists a quadratic increase with the circumference factor. Damping or antidamping of stabilizing motion can be neglected except for storage of particles. So particle-particle interaction for the accelerator under consideration can be neglected. (auth)

4167 INVESTIGATIONS OF IRIS-LOADED DEFLECTORS. Hahn, H.; Halama, H. J. (Brookhaven National Lab., Upton, N. Y.). Nucl. Instrum. Methods, 45: 141-50(Nov.-Dec. 1966). (BNL-10098).

Theoretical and experimental investigations of the iris-loaded waveguides being used as deflectors in the Brookhaven rf beam separator are presented. The experimental arrangements for deflection tests are detailed and the analysis of the results is given. The deflector constant of the BNL structure was found to be $Kl = 5.220 \pm 0.038\ k\Omega^{\frac{1}{2}}$, whence the final result that $R/Q = 1.57 \pm 0.09\ k\Omega/m$. This is in good agreement with predictions based either on perturbation measurements or on computations. A compilation of theoretical figures of merit for more than one hundred structures is given. (auth)

4168 HIGH POWER SOLID STATE SEPTUM MAGNET SYSTEM. Huttar, Daniel E. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). pp 950-5 of Proceedings of the National Electronics Conference. Vol. XXII. Chicago, National Electronics Conference, Inc., 1966.

Design details are presented on the final extraction magnet of the Princeton–Pennsylvania 3 BeV Proton Synchrotron. (B.G.D.)

4169 POWER SUPPLY AND LOGIC FOR A 2 MJ ENERGY STORAGE SYSTEM. Vogel, H. F.; Reed, F. (Argonne National Lab., Ill.). pp 956-61 of Proceedings of the National Electronics Conference. Vol. XXII. Chicago, National Electronics Conference, Inc., 1966.

A power supply (assembled with a 6-phase, 1-MVA, 520-V (dc) mercury-arc rectifier) and logic circuits for a 2.5-MJ energy storage capacitor bank used for pulsing a magnet at a repetition rate of 9 pulses per minute to a cylindrical field with flux den-

sity of 20 T for producing precession of heavy magnetically polarized nuclear particles whose magnetic moment is thus determined are described. The logic employs a 1/100 scale model whose currents and voltages are compared with those of the main circuit. (auth)

4170 PROPOSAL FOR A FLAT-TOP PULSER FOR DESY. Hemmie, G. 3p. (In German). (CONF-660104-4). ORAU. Gmelin, AED-CONF-66-174-9.

From Symposium on Magnet Flat Topping for Rapid Cycling Particle Accelerators, Princeton, N. J.

A circuit is given that can be used as the starting point for the development of a flat top pulser for DESY. (J.S.R.)

4171 CHARGED PARTICLE GENERATOR. Tsuchimoto, Takashi (to Kabushiki Kaisha Hitachi Seisakusho). U. S. Patent 3,275,867. Sept. 27, 1966. Priority date Feb. 15, 1962, Japan.

A charged particle generator which by means of a single generating device both ions and electrons can be generated is described. This ion source is of simple construction and operation and is adaptable for miniaturization. The operation of switching between the ion and electron generation consists of changing the polarity of the accelerating voltage. This ion source is capable of producing with stability a charged particle beam of high current with any desired energy. (J.F.P.)

4172 CYCLOTRON WAVE DOUBLE-STREAM DEVICES. Vural, Bayram (to Radio Corp. of America). U. S. Patent 3,270,241. Aug. 30, 1966. Filed Sept. 8, 1965.

Improved methods and means for coupling an electron stream to an input or output fast wave transmission line to a fast cyclotron wave mode of an electron stream drifting in a magnetic field without the use of periodic structures are given. A double-stream amplifier tube having inhomogeneous axial magnetic and electric fields and fast wave input and output couplings is described. (J.F.P.)

4173 RADIO-FREQUENCY PARTICLE SEPARATOR. Loew, Gregory A. (to U. S. Atomic Energy Commission). U. S. Patent 3,278,745. Oct. 11, 1966.

A particle separator for separating charged particles moving at different velocities in a high-energy secondary beam in a linear accelerator is described. Radio-frequency waves in the TM_{01} mode are applied to the accelerator to generate a high-energy primary beam which strikes a target to generate the secondary beam. Particles of different velocities in the secondary beam are caused to drift apart by half a wavelength of the applied rf waves prior to injection into a cylindrical disk-loaded waveguide. The disks in the waveguide have apertures which are aligned along a common axis that is parallel to, but off-center from the axis of the waveguide. As the particles pass through the apertures, they are differentially deflected in a transverse direction by rf energy in the TM_{01} mode applied to the waveguide. Distinct beams of particles are formed thereby according to their respective velocities. (AEC)

4174 DEVICE FOR THE REMOTE CONTROL OF THE PULSES OF THE ION-BEAM CREATED BY AN ION-SOURCE. (to Commissariat a l'Energie Atomique). British Patent 1,047,366. Nov. 2, 1966. Priority date July 22, 1964, France.

The device for the remote control of pulses of an ion beam created by an ion source submitted to an hf electric field comprises in series a pulse generator, a differentiator actuated by the pulse generator and adapted to alter the signals emitted by the latter, a transformer which receives the signals from the differentiator, an integrator, a modulator, and an hf oscillator coupled to the ion source. Whenever the oscillator is blocked by signals from the modulator the ion beam is substantially nil; whenever the oscillator is unblocked the ion beam is at a maximum. (J.F.P.)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 3254, 3259, 3291, and 4229.

4175 (AD-632534) PRELIMINARY INVESTIGATION OF TRANSPORT-BRANCHING PROCESSES. Shiffman, Bernard (RAND Corp., Santa Monica, Calif.). Mar. 1966. Contract SD-79. 34p. (RM-4290-ARPA). CFSTI $2.00 cy, $0.50 mn.

A probabilistic discussion of one-dimensional multitype neutron transport processes is given, and the invariant imbedding technique is applied to the generating functions of the emitted neutrons. A system of simultaneous partial differential equations for these generating functions is then derived. The well-known Ricatti equation for the expected reflected flux follows from these differential equations. (auth)

4176 (AWRE-O-40/66) THE MULTIGROUP NEUTRON TRANSPORT PERTURBATION PROGRAM DUNDEE. Hemment, Pamela C. E.; Pendlebury, E. D.; Adams, M. J.; Brett, B. A.; Sams, D. (Atomic Weapons Research Establishment, Aldermaston (England)). Oct. 1966. 51p. Dep. mn. BIS $1.60. HMSO 8s.

A description is given of the IBM 7030 (Stretch) program DUNDEE which has been written to facilitate the application of first order perturbation theory to problems in multigroup neutron transport theory. It uses as part of its input perturbation functions (on tape) calculated by the S_n program STRAINT, and can be used in particular to calculate the sensitivity of the inverse reactivity B, and time constant λ no changes in the cross section data. (auth)

4177 (BMwF-FBK-66-19) EXAKTE LOESUNGEN DES MILNE-PROBLEMS FUER ZWEI HALBRAEUME MIT VERSCHIEDENEN MEDIEN UND DES PROBLEMS EINER UNENDLICH AUSGEDEHNTEN PLATTE NACH DER KUGELFUNKTIONS-METHODE. (Exact Solutions of the Milne-Problem for Two Half-Spaces with Different Media and of the Problem of an Infinite Plate by the Method of Spherical Harmonics). Korn, A. (Bundesministerium fuer Wissenschaftliche Forschung, Bad Godesberg (West Germany)). July 1966. 28p. (In German). Dep. mn. Gmelin: DM 5,60.

W. Kofink published a solution in P_{L+1} approximation for the stationary monoenergetic Boltzmann equation in plane geometry and for linear anisotropic scattering using the spherical harmonics method. Taking this solution, two problems in plane geometry were solved: the problem of two adjacent half-spaces and the problem of an infinitely extended slab surrounded by homogeneous matter. In the limit $L + 1 \to \infty$ exact solutions of these two problems were obtained which are very suitable for numerical calculations. (auth)

4178 (LA-3530) PROGRAMS DESIGNED FOR PROCESSING MONTE CARLO EVENTS TAPES. Streetman, J. Robert (Los Alamos Scientific Lab., Univ. of California, N. Mex.). May 1966. Contract W-7405-eng-36. 36p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

A program is described for processing events tapes from a neutron Monte Carlo calculation. The saving of the events of a Monte Carlo on tape for possible future processing is a useful technique in that the original program need not go to such lengths to be comprehensive in the data accumulated. The program described is capable of regenerating the information originally accumulated by the Monte Carlo and has been used to collect additional information the need for which was not foreseen when the Monte Carlo was run. (auth)

4179 CONSTRUCTING A GENERAL SOLUTION TO A SYSTEM OF MULTI-GROUP TRANSPORT EQUATIONS. Ivanov, L. D. Zh. Prikl. Mekh. Tekh. Fiz., No. 3, 58-62(May-June 1966). (In Russian).

A proof is given for a theorem on the completeness of eigenfunctions within the (-1.1) to (0.1) range of variation of the angular variable. Eigenfunctions and eigenvalues are discussed, and two theorems are presented for a system of arbitrary functions Fi(t) and F'i(t), which satisfy Hoelder's boundary conditions at $|t| \leq 1/\sigma_0 = \theta_0$ and $0 \leq t \leq 1/\sigma_0 = \theta_0$, respectively. A simpler proof is given for the completeness of the eigenfunctions involved. The results of the calculations can be used in defining the critical size of a plane slab reactor and in solving Milne's problem in a multi-group approximation. (ATD)

4180 EXACT SOLUTION OF THE MONOENERGETIC NEUTRON TRANSPORT EQUATIONS USING A LINEAR ANISOTROPIC SCATTERING FUNCTION IN PLANE GEOMETRY. PART II. Haungs, Guenter (Technische Hochschule, Karlsruhe, Ger.). Nukleonik, 8: 356-61(Aug. 1966). (In German).

The method of the transition to the exact solution used previously is extended to the calculation of the neutron density and current in the scattering medium. For the special cases c = 1 and $\gamma_t = 1$ (= isotropic scattering) the formulas simplify and the h-function previously defined coincides with the H-function of Chandrasekhar. Diagrams show the influence of the anisotropy on the direct flux at the boundary. (auth)

4181 EXACT SOLUTION OF THE MONOENERGETIC NEUTRON TRANSPORT EQUATIONS USING A LINEAR ANISOTROPIC SCATTERING FUNCTION IN PLANE GEOMETRY. PART I. Haungs, Guenter (Technische Hochschule, Karlsruhe, Ger.). Nukleonik, 8: 348-56(Aug. 1966). (In German).

The spherical harmonics method with linear anisotropic scattering functions, developed by W. Kofink, is used to derive the solution for the classical example of transport theory, the Milne problem. This solution is given in a P_L approximation and then, using the generalized H-function of Chandresekhar the limit $L \to \infty$ is evaluated and the exact solution is obtained. The important quantities are calculated numerically and graphed. The method sketched for the transition to the exact solution is not restricted to the Milne problem; it can be transferred to multilayer problems in plane geometry. (tr-auth)

4182 LOW-TEMPERATURE NEUTRON-IRRADIATION DAMAGE AND ITS RECOVERY IN HIGH-PURITY GERMANIUM. Swanson, M. L. (Atomic Energy of Canada, Ltd., Chalk River, Ont. Max-Planck-Institut fuer Metallforschung, Stuttgart). Can. J. Phys., 44: 2181-99(Oct. 1966). (AECL-2484).

Neutron-irradiation damage at 1.9 and 4.2°K and its recovery to 300°K were investigated in high-purity germanium by means of photoconductivity measurements. It was observed that the photoresistivity increased linearly with the irradiation time up to doses of 5×10^{12} fission-neutrons/cm^2 for samples containing approximately 7×10^{13} impurity atoms/cm^3, but that some saturation occurred for less pure samples (containing 10^{15} impurity atoms/cm^3). Almost complete recovery of the irradiation-induced changes in photoresistivity of the higher-purity n- and p-type samples occurred in three stages, centered at 32, 95, and 180°K. The results were independent of the method and degree of carrier excitation. The damage rates and recovery were explained in terms of the recombination of photocarriers through the simple vacancy and interstitial-type defects which were created by the irradiation and were subsequently removed by thermal migration. (auth)

4183 CONSTRUCTION AND PERFORMANCE OF A SIMPLE NEUTRON SOURCE. Juliano, Jose O. (Philippine Atomic Research Center, Diliman, Quezon City); Buot, Felixberto. Philippine J. Sci., 94: 221-34(June 1965).

A neutron source consisting of a cylindrical Fe drum completely filled with paraffin which serves as a neutron moderator and shield for fast neutrons from the $^9Be(\alpha,n)^{12}C$ reaction is described. The Pu-Be source is placed in an Al tube along the central axis. Some preliminary applications of the source to the production of radioisotopes and to activation analysis are discussed. (D.C.W.)

4184 NEUTRONS FROM (α,n) SOURCES. Rubbino, A. (Goethe Univ., Frankfurt am Main); Zubke, D.; Meixner, C. Nuovo Cimento (10), 44B: 178-81(July 11, 1966).

The neutron energy spectrum of a Pu-Be source was measured. Good energy resolution was achieved, and the detailed structure of the spectrum was evidenced. The results are discussed and are compared with other measurements made with Pu-Be, Po-Be and Am-Be sources. (auth)

4185 SLOW NEUTRON SCATTERING BY SOLID CH_4 AND NH_4I. Kosaly, G.; Solt, G. (Central Research Inst. for Physics, Budapest). Physica, 32: 1571-81(Sept. 1966).

In order to get information on the rotational freedom of the molecule, cross section formulas were evaluated, using the phonon expansion for the translational modes combined with the assumption of free rotation. The results were applied to analyze neutron scattering data in the case of highest temperature modification of the solid methane and ammonium iodide. Comparison of theoretical calculations and experiments has shown, that (1) data of neutron elastic form factor measurements are not in conflict with a calculation based on the hypothesis of free rotation in room temperature ammonium iodide; (2) double differential cross section data cannot be fitted assuming free rotation in solid methane at 86°K, thus such an experiment clearly exhibits rotational hindrance of the CH_4 molecule. (auth)

4186 NATURAL ROTATION OF THE NEUTRON SPIN DIRECTION. Baryshevskii, V. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 4: 72-4(July 1966). (In Russian).

The contribution of the spin–orbit interaction to the amplitude of the zero-angle scattering of neutrons on molecules is considered. It is shown that if neutrons pass through matter, consisting of molecules without mirror symmetry, this contribution leads to the rotation of the neutron polarization vector around the direction of motion, in analogy with the natural rotation of light. (auth)

4187 FILTER DIFFERENCE METHOD FOR MEASURING INELASTIC SCATTERING OF SLOW NEUTRONS. Pan, S. S.; Webb, F. J.; Yeater, M. L. (Rensselaer Polytechnic Inst., Troy, N. Y.). Nucl. Instrum. Methods, 42: 197-205(July 1966). (RPI-328-43).

A filter-difference method is described for measuring inelastic scattering of neutrons with initial energies between 0.1 and 1.0 eV in transitions to a final energy near zero. An electron linear accelerator provides an intense pulsed neutron source of large area, enabling measurements to be made at significantly higher energies than is possible with a reactor. The resolution (±4 to 8% in neutron energy change of 0.1 to 0.5 eV) is comparable to that of existing phased chopper apparatus in this energy range. Measurements on polyethylene, titanium hydride, and zirconium hydride demonstrate the use of the method in surveying a whole range of neutron energy change in a single experiment. (auth)

4188 METHOD OF DETERMINATION OF THERMAL NEUTRON BEAM COLLIMATION. Inouye, T.; Ogawa, K. (Tokyo Shibaura Electric Co., Ltd., Kawasaki). Nucl. Instrum. Methods, 42: 309-11(July 1966).

An arrangement for collimating thermal-neutron beams is described, together with a method for determining the collimation of the beam. (D.C.W.)

4189 ROLE OF DIFFUSION PROCESSES IN THE SCATTERING OF SLOW NEUTRONS IN LIQUIDS. Ivanov, G. K. (Inst. of Chemical Physics, Academy of Sciences, USSR). Zh. Eksp. Teoret. Fiz., 51: 1120-6(Oct. 1966). (In Russian).

The differential cross section for incoherent quasi-elastic scattering of slow neutrons in liquids is calculated by dividing the whole region of movement of the scattering atom into recurrent statistically independent sections. Monatomic as well as molecular liquids are considered. Atomic vibrations, diffusion of vibration centers, and arbitrary movements of particles from one equilibrium position to another are taken into account for the monatomic liquids. Besides the types of motion mentioned, reorientation of molecules with respect to various axes are taken into account for the molecular liquids. The results obtained explain the fine structure of the neutron quasi-elastic scattering spectra observed in water. (auth)

4190 AEC-ENEA SEMINAR ON THE EVALUATION OF NEUTRON CROSS-SECTION DATA, MAY 3–7, 1965, BROOKHAVEN NATIONAL LABORATORY. Paris, European Nuclear Energy Agency, [1965]. 450p. (CONF-650524).

Separate abstracts were prepared for 2 of the 38 papers included. Five other papers were previously abstracted for NSA (19: 29233, 33238, 37784, 39778 and 20: 1160). The remaining papers deal with the compilation, evaluation, processing, and storage of nuclear data (primarily neutron cross-section data). (D.C.W.)

For abstracts of individual papers see: 4304 and 4305.

4191 NEUTRON GENERATOR. Komai, Kenichiro (to Hitachi Ltd.). Japanese Patent 1965-20636. Sept. 14, 1965. Filed Mar. 10, 1964.

A neutron generator is proposed in which a high degree of safety is assured with automatic control of the ion beam of the generator so that it is operated only when a material is in its irradiation compartment. The control device consists of a detector for entrance and exit of a sample material, an amplifier for the electric output of the detector, a light generator energized by the output of the amplifier, a light detector, and a relay contact for controlling the ion source circuit of the neutron generator. (NSA of Japan)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 4207, 4208, 4338, and 4369.

4192 PRESENT STATUS ON THE HYPERFRAGMENT WORK. Bhowmik, B. (Univ. of Delhi). pp 670-89 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

The discussion of hyperfragment physics includes a review of hyperfragment production, decay modes, and branching ratio, the nonmesic/mesic ratio, lambda stimulated decay, the π^0/π^- decay ratio, and the spin of hypernuclei. Also reviewed are hyperfragment lifetimes, the binding energy of the lambda hyperon, heavy hyperfragments, D_Λ estimates, and problems concerning hyperfragments. (J.F.P.)

4193 STUDY OF MULTI-NUCLEON INTERACTIONS OF Λ^0 IN HYPERFRAGMENTS. Burte, D. P.; Chaudhari, K. N.; Ganguli, S. N.; Rao, N. K.; Swami, M. S. (Tata Inst. of Fundamental Research, Bombay). pp 734-8 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

An analysis of 1101 nonmesic hyperfragments (NMHF), produced by 3.5- and 17.2-GeV/c π^-, and 23-GeV/c protons in nuclear emulsions was made, and from this sample, those having two fast particles (range ≥ 2 mm) at the decay vertices of NMHF were selected to study the stimulated decay of Λ^0 by two or more nucleons in NMHF. From this study it is concluded that the contribution of Λ^0–multinucleon interaction to the decay of NMHF is small and there is a strong evidence for the existence of final-state interactions in these decays. (auth)

4194 THE SCATTERING OF 135 MeV PROTONS BY DEUTERONS. Esten, M. J.; Griffith, T. C.; Lush, G. J.; Metheringham, A. J. (London Univ.). Nucl. Phys., 86: 289-306(1966).

Differential cross sections and energy spectra for both the fast neutrons and for the low-energy spectator protons emitted in the d(p,n)2p reaction at 135 MeV were measured using a high-pressure Wilson cloud chamber. The results are compared with impulse-approximation calculations; and, in the case of the energy spectrum of the spectator protons, the ratio of the theoretical to experimental cross sections is extrapolated to the pole at −1.113 MeV. (auth)

4195 SCATTERING OF POLARIZED PROTONS BY DEUTERIUM FROM 1 TO 3 MeV. Traechslin, Walter (Univ. of Basel); Brown, Louis. Nucl. Phys., 6701A: 593-6(1967).

Polarized proton beams of energies 0.99, 1.32, 2.21 and 3.12 MeV were used to measure the angular distributions of the polarization in the interaction D(p,p)D. The accuracy of the data points ranges from 0.005 to 0.011. A positive value of about 0.01 is discerned at the lowest energy for cms angles from 60° to 120°. This effect increases to about 0.05 at the highest energy with a maximum near 120°. (auth)

4196 MEASUREMENT OF SOME GAMMA-RAY ENERGIES SUITABLE FOR ROUTINE ENERGY CALIBRATION. Black, W. W.; Heath, R. L. (Idaho Nuclear Corp., Idaho Falls). Nucl. Phys., 6701A: 650-6(1967).

The energies of several gamma transitions were measured using a Ge(Li) spectrometer. The isotopes and the corresponding transition energy measurements in keV are ^{141}Ce(145.44 ± 0.05), ^{139}Ce(165.85 ± 0.05), ^{51}Cr(320.07 ± 0.05), ^{7}Be(477.57 ± 0.05), ^{85}Sr (513.95 ± 0.07), ^{95}Nb(765.83 ± 0.07), ^{54}Mn(834.84 ± 0.07), ^{46}Sc (889.25 ± 0.07, 1120.50 ± 0.07), ^{88}Y(898.01 ± 0.07, 1836.08 ± 0.07), ^{92}Nb(934.51 ± 0.07), ^{207}Bi(1063.63 ± 0.07), ^{65}Zn(1115.51 ± 0.07), and ^{22}Na(1274.52 ± 0.07). (auth)

4197 CORRECTIONS TO THE RANDOM-PHASE APPROXIMATION: DIPOLE STRENGTH DISTRIBUTION FROM TWO-QUASI-BOSON STATES IN ^{12}C. da Providencia, J. (Univ., Coimbra, Portugal). Nucl. Phys., 6701A: 597-600(1967).

The formalism developed previously is applied to the calculation of the distribution of dipole strength in ^{12}C, arising from the excitation of two-quasi-boson states. These states give significant contributions at energies above the giant resonance. The theoretical predictions are compared with recent experimental results. (auth)

4198 METHOD FOR DETERMINING THE INTENSITY OF COMPLEX PHOTOPEAKS. Mundschenk, H. (Univ., Mainz). Nucl. Instrum. Methods, 45: 77-86(Nov.-Dec. 1966). (In German).

The use of empirical functions instead of the normal distribution function to describe the shape of photopeaks is proposed. Taking into account the fact that in a wide energy and intensity range photopeaks are exactly described by two empirical functions which are normalized with respect to the fractional peak height, a procedure is derived which allows the decomposition of overlapping peaks even in the case of a small energy separation and an unfavorable intensity ratio. (D.C.W.)

4199 THE SPREADING OF NUCLEAR SPIN POLARIZATION IN STATIC AND FLOWING ^{3}He. Escher, G.; Turowski, P.

(Technische Hochschule, Karlsruhe, Ger. Kernforschungszentrums, Karlsruhe, Ger.). Z. Angew. Phys., 21: 500-3 (1966). (In German).

The polarization of the ^{3}He nuclear spin generated by optical pumping is propagated from the polarization cell to attached spaces largely free of loss, if the polarization cell and the attached spaces are kept under the influence of a uniform magnetic field of sufficient homogeneity. The degree of polarization will be reduced the more strongly the larger the relative inhomogeneities of the magnetic field in the space area covered by ^{3}He. Employing the field of the earth for generating and carrying the polarization results in only relatively low degrees of polarization. This may be due to the fact that the weak inhomogeneities of the magnetic field present in the laboratory in this case present relatively high relative inhomogeneities. (auth)

4200 CHARGED-PION ELECTROPRODUCTION ON LIGHT NUCLEI. Ferroni, S. (Ecole Normale Superieure, Orsay, France); Gracco, V.; Lehmann, P.; Merkel, B.; Schaerf, C. Nuovo Cimento (10), 45A: 930-6(Oct. 21, 1966).

The differential cross section for the photoproduction of charged pions on light nuclei was measured for different values of the photon energy using the excitation-curve method. Hydrogen, lithium-6, lithium-7 and carbon were studied. No correlation with the detailed structure of the final nuclei was found. The data seem consistent with a model where the nucleons are considered as independent emission centers and where reabsorption from the other nucleons in the nucleus is taken into account. This appears to be valid both for single- and double-pion photoproduction. (auth)

4201 COUPLING CONSTANTS IN MUON CAPTURE. Rood, H. P. C. (CERN, Geneva). Nuovo Cimento, Suppl. (1), 4: 185-202(1966).

Theoretical predictions for the coupling constants in meson(μ) capture are summarized and are compared with experimental observations. Numerical results for capture by ^{12}C, ^{3}He, and hydrogen are discussed. The extent to which coupling constants can be determined by present experiments is emphasized. (D.C.W.)

4202 ON MEASURING THE ABSOLUTE YIELD OF 14 MeV NEUTRONS BY ASSOCIATED PARTICLE COUNTING. Robertson, J. C.; Zieba, K. J. (National Physical Lab., Teddington, Eng.). Nucl. Instrum. Methods, 45: 179-80(Nov.-Dec, 1966).

The sources of error in the measurement of neutron yields from the T(d,n)^{4}He reaction using the associated-particle method are discussed. It is concluded that the contribution to the associated-particle spectrum from the helium in the tritium target must be taken into account. (D.C.W.)

4203 TABLE DES ISOTOPES. VOLUME II. (Tables of Isotopes. Volume II). Pannetier, Raymond. Vade-Mecum du Technicien. (Technicians Handbook). [Moulins, France, Maisonneuve S.A., 1965]. 300p.

A compilation is presented of the physical, chemical, nuclear, and radioactive characteristics of all known radioactive isotopes. (J.S.R.)

Nuclear Properties and Reactions, 6 ≤ A ≤ 19

Refer also to abstracts 4184, 4192, 4193, 4196, 4200, 4201, 4203, 4234, 4346, 4354, 4355, and 4369.

4204 (NYO-3525-11) STATES WITH T = 1, 2 OF A = 16 AND T = $\frac{3}{2}$ OF A = 15,17 NUCLEI. Soga, Michitoshi (Bartol Research Foundation, Swarthmore, Pa.). Sept. 12, 1966. Contract AT(30-1)-3525. 10p. (CONF-660906-40). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From International Conference on Nuclear Physics, Gatlinburg, Tenn.

A consistent description of the lowest T = 1 and T = 2 levels of A = 16 nuclei and T = $\frac{3}{2}$ levels of A = 15 and A = 17 nuclei is given by the product wave functions of low-lying whole states of A = 14 and A = 15 nuclei and low-lying particle states of A = 17 and A = 18 nuclei. The spin of the second level with T = 2 of A = 16 nuclei is discussed. (auth)

4205 (ORNL-3884) LITERATURE SURVEY OF RADIOCHEMICAL CROSS-SECTION DATA BELOW 425 MeV. Bertini, H. W.; Guthrie, M. P.; Pickell, E. H.; Bishop, B. L. (Oak Ridge National Lab., Tenn.). Oct. 1966. Contract W-7405-eng-26. 55p. Dep. mn. CFSTI $3.00 cy, $0.50 mn.

The results of a literature survey that was made of radiochemical cross sections below 425 MeV are given in tabular form. The cross-section data are tabulated for reactions involving incident protons, neutrons, and π mesons in the energy range from about 20 to 400 MeV interacting with nuclei ranging from lithium to the heavy-weight elements. (auth)

4206 MECHANISM FOR PRODUCTION OF HYPERFRAGMENT. Burte, D. P.; Chaudhari, K. N.; Ganguli, S. N.; Rao, N. K.; Swami, M. S. (Tata Inst. of Fundamental Research, Bombay). pp 690-9 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics, Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

Hyperfragments (HFS) produced in interactions of high-energy pions (3.5 and 17.2 GeV/c) and protons (23 GeV/c) with emulsion nuclei were investigated and the production mechanism was studied. From these studies it is concluded that long-range HFs) ($\geq$20 μm) which are due to fragments with mass number $\lesssim$15, are produced in the evaporation stage of the disintegrations of Ag and Br nuclei of the emulsion and the short range HFs ($\leq$10 μm) which have a broad mass spectrum with mass numbers between 20 and 90, are partly due to residues of the target nuclei and partly due to fission-type processes that occur in high-energy interactions. A qualitative discussion of the sticking probability of Λ^0 to fragments is given. (auth)

4207 ANALYSIS OF NON-MESIC HYPERFRAGMENTS. Chaudhari, K. N.; Ganguli, S. N.; Rao, N. K.; Swami, M. S. (Tata Inst. of Fundamental Research, Bombay). pp 720-9 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics, Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

An investigation was made of 463 nonmesic hyperfragments (HFs), of range R > 20 μm, produced in interactions of high-energy pions (3.5 GeV/c and 17.2 GeV/c) and protons (23.0 GeV/c) with emulsion nuclei. The charge spectrum (E $\geq$ 30 MeV) as a function of the charge of the HF was obtained. Also the charge spectrum of 68 MHFs (R > 20 μm) was obtained. The nonmesonic/mesonic ratio and the An/Ap stimulation ratio as a function of charge of the HF are given. (auth)

4208 STUDY OF MESIC-HYPERFRAGMENTS. Chaudhari, K. N.; Ganguli, S. N.; Rao, N. K.; Swami, M. S. (Tata Inst. of Fundamental Research, Bombay). pp 730-3 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

Binding energies of 141 mesic hyperfragments from K^- interactions at rest in nuclear emulsion are presented. (auth)

4209 MAGNETIC MOMENTS WITH HARTREE–FOCK WAVE FUNCTIONS. Ripka, G.; Zamick, L. (Centre d'Etudes Nucleaires, Saclay, Gif-sur-Yvette, France). Phys. Lett., 23: 347-9(Nov. 7, 1966).

The experimentally known magnetic moments of odd-A nuclei between A = 11 and 35 were calculated using self-consistent Hartree-Fock wave functions. (auth)

4210 AN INVESTIGATION OF THE ^{9}Be(^{3}He,p)^{11}B REACTION AT LOW ENERGIES. Coker, W. R. (Univ. of Georgia, Athens); Duggan, J. L.; Miller, P. D. Nucl. Phys., A6702: 97-111(1967).

Angular distributions and excitation functions were measured for proton groups leading to the 4.46, 5.03, 7.30, 7.99, 8.57 and 8.92 MeV excited states of ^{11}B using ^{3}He particles in the energy range 1 to 3 MeV. The experimental measurements are analyzed in terms of a two-particle plane-wave stripping formalism and a distorted-wave Born approximation (DWBA). The results of both approaches are consistent with investigations which have been made on this reaction at higher energies. Parities assigned are as follows: 4.46(−), 5.03(−), 7.30(+), 7.99(+), 8.57(−), 8.92(−). (auth)

4211 THE ^{11}B(^{3}He,^{6}Li)^{8}Be REACTION. Young, F. C.; Forsyth, P. D.; Marion, J. B. (Univ. of Maryland, College Park). Nucl. Phys., A6702: 209-21(1967). (ORO–2098–51).

The ^{11}B(^{3}He,^{6}Li)^{8}Be reaction (Q = 4.56 MeV) was studied for bombarding energies from 1.4 to 5.8 MeV. Angular distributions were measured at 3.0 and 5.2 MeV. It is suggested that the reaction proceeds by a "cluster pickup" mechanism which requires substantial (^{3}He + t) and (^{8}Be + t) configurations for the ground states of ^{6}Li and ^{11}B, respectively. The reaction was also observed leaving ^{8}Be in the (2.9-MeV) first excited state with ^{6}Li in the ground state, and leaving ^{6}Li in the (3.56-MeV) second excited state with ^{8}Be in the ground state. These reactions indicate that the ^{11}B ground state wave function must also contain a large fraction of the configuration (^{8}Be* + t), but that the wave function of the 3.56-MeV state of ^{6}Li contains much less of the (^{3}He + t) configuration than does the ground state. (auth)

4212 SOME (n,p) REACTION CROSS SECTIONS FOR 14.7 MeV NEUTRONS. Csikai, J.; Nagy, S. (Inst. of Nuclear Research, Academy of Sciences, Debrecen, Hungary). Nucl. Phys., A6702: 222-4(1967).

Total (n,p) reaction cross sections were determined for 11 nuclei between A = 14 and 190 at a neutron energy of 14.7 MeV. A suggested minimum in the cross section for nuclei with a closed proton shell at Z = 20 was not confirmed in the measurements. The results obtained for the different Ca and Os isotopes, support the empirical relation for the dependence of $\sigma_{n,p}$ on the mass number at fixed Z. (auth)

4213 METHODS OF DETERMINATION OF INTERNAL CONVERSION COEFFICIENTS. Subba Rao, B. N. (Tata Inst. of Fundamental Research, Bombay). Nucl. Instrum. Methods, 45: 22-40(Nov.-Dec. 1966).

A review is presented of several methods for determining internal conversion coefficients, primarily for the conversion process in the K-electron ($1s_{\frac{1}{2}}$) shell of atoms. (D.C.W.)

4214 VIRTUAL TRANSITIONS TO THE CONTINUUM IN ^{16}O. Beres, W. P. (Univ. of Maryland, College Park). Phys. Rev. Lett., 17: 1180-4(Dec. 5, 1966).

The energy shifts of the negative-parity levels of ^{16}O due to low-momentum, off-the-energy-shell transitions of both neutrons and protons were calculated. (D.C.W.)

4215 HARTREE–FOCK CALCULATIONS IN LIGHT NUCLEI. Boeker, E. (Oxford Univ.). Nucl. Phys., A6702: 27-43(1967).

The wave functions and energies of the ^{8}Be and ^{12}C ground states and the excited 4p4h state in ^{16}O are determined by the Hartree-Fock method. The unknown single-particle wave functions are expanded in a restricted set of spherical harmonic oscillator wave functions on a Cartesian basis. This basis is very suitable for study of deformed states. In a sense the resulting linear combinations are equivalent to deformed harmonic oscillator wave functions. It appears then that there are different deformations in the different shells with different oscillator frequencies. For an interaction which gives reasonable binding energies and densities throughout the periodic system the 4p4h state comes down to 13-MeV excitation. (auth)

4216 A STUDY OF THE ^{6}Li(p,n)^{6}Be REACTION BY THE NEUTRON THRESHOLD TECHNIQUE. Honsaker, John L. (California Inst. of Tech., Pasadena). Nucl. Phys., 6701A: 545-57(1967).

The reaction ^{6}Li(p,n)^{6}Be was studied by slow-neutron detection, with particular attention to the ^{6}Be ground-state threshold. The detector response was calculated by a Monte Carlo technique and was verified with a measurement of the ^{7}Li(α,n)^{10}B threshold. An analysis of the shape of the ^{6}Be threshold indicated that both s- and p-wave neutrons contribute significantly to the reaction. The results depend on what mode of decay is assumed for the ground state of ^{6}Be. If a two-stage process is assumed, with either an alpha particle and an unbound diproton or ^{5}Li and a proton as intermediate state, the width is found to be 95 ± 28 keV and the Q-value obtained for the ^{6}Li(p,n)^{6}Be reaction is −5074 ± 13 keV. It was not possible to determine which process is predominant. No higher thresholds in the slow neutron yield up to 4 MeV of excitation in ^{6}Be were observed. The data above the ground-state threshold are consistent with a broad excited state of ^{6}Be or with the occurrence of other neutron-producing reactions. (auth)

4217 POLARIZATION OF PROTONS FROM THE ^{9}Be(d,p)^{10}Be REACTION. Blue, R. A.; Stout, K. J.; Marr, G. (Ohio State Univ., Columbus). Nucl. Phys., 6701A: 601-11(1967).

The polarization of protons from the ^{9}Be(d,p)^{10}Be reaction was measured for deuteron energies between 1 and 6 MeV. Angular distributions of the polarization for the ground-state proton group (Q = 4.59 MeV) were measured for laboratory angles between 10 and 135° at 2.5, 4.0 and 5.5 MeV. The polarization at a laboratory angle of 30° was measured in 0.2-MeV steps between 1 and 6 MeV. In addition the polarization of protons leaving ^{10}Be in its first excited state (Q = 1.22 MeV) was measured between 10 and 90° for a deuteron bombarding energy of 5.5 MeV. Measurements were made by conventional double-scattering techniques using elastic scattering from helium at 45° as the analyzer. The results show a strong energy dependence contrary to what one might expect on the basis of the lack of structure in the cross section. The maximum polarization observed at each energy is about 0.35. (auth)

4218 THE NEUTRON BINDING ENERGIES OF ^{10}Be AND ^{24}Na DETERMINED FROM NEUTRON CAPTURE GAMMA-RAY ENERGY MEASUREMENTS. Greenwood, R. C. (Idaho Nuclear Corp., Idaho Falls). Phys. Lett., 23: 482-4(Nov. 21, 1966).

A "boot-strap" approach was used to obtain the neutron binding energies of ^{10}Be and ^{24}Na from thermal-neutron capture gamma experiments. Values of 6811.9 ± 0.4 and 6959.3 ± 0.4 keV were obtained for ^{10}Be and ^{24}Na, respectively. (auth)

4219 T = $\frac{3}{2}$ LEVELS IN ^{17}F. Adelberger, E. G.; Barnes, C. A. (California Inst. of Tech., Pasadena). Phys. Lett., 23: 474-6(Nov. 21, 1966).

Levels with T = $\frac{3}{2}$ were observed in ^{17}F at excitation energies of 11.195, 12.544 and 13.055 MeV in the reaction ^{15}N(^{3}He,n). Angular distributions lead to spin assignments of $\frac{1}{2}^-$ for the 11.195-MeV level, and $\frac{3}{2}^-$ or $\frac{5}{2}^-$ for the level at 12.544 MeV. (auth)

4220 ENERGY SPECTRUM OF NEUTRONS FROM (p,n) REACTION IN ^{9}Be. Das, J. M.; Sen Gupta, H. M. (Univ. of Dacca, Pakistan). J. Natur. Sci. Math., 6: 33-9(Apr. 1966).

Neutron energy spectra from (p,n) reactions in ^{9}Be were measured using nuclear emulsions as both radiators and detectors and various groups were identified as arising from different levels in ^{9}B. A strong indication of the existence of a previously suspected broad level corresponding to the 1.75-MeV level in ^{9}Be was found at 1.31 MeV. (auth)

4221 THE EXCITED STATES OF ^{10}B. Fife, A. A.; Neilson, G. C.; Dawson, W. K. (Univ. of Alberta, Edmonton). Nucl. Phys., A6702: 164-76(1967).

The reaction ^{9}Be(d,n)^{10}B was studied by time-of-flight techniques at bombarding energies of 3.0, 3.5 and 5.5 MeV. A total of 16 levels of ^{10}B was identified up to 7.56-MeV excitation, but no significant evidence was found for reported states at 5.18, 5.58, 6.40 and 6.77 MeV. The DWBA theory was used to interpret the angular distributions for l-values and spectroscopic factors, and plane wave theory was used in cases where the ^{10}B levels become unbound. The spectroscopic factors were found to depend sensitively on optical parameter uncertainties and also on whether or not finite-range and non-local effects were included. (auth)

4222 MEAN LIFETIME OF THE 8.88-MeV STATE IN ^{16}O. Pixley, R. E. (Centre de Recherches Nucleaires, Strasbourg. Univ., Zurich); Benenson, Walter. Nucl. Phys., A6702: 177-98 (1967).

The mean life of the 8.88-MeV state in ^{16}O was measured using the particle-gamma coincidence form of the Doppler-shift-attenuation method. The value obtained is $1.92 \pm 0.29 \times 10^{-13}$ sec. Detailed calculations relating to the Doppler-shift measurement were made for the stopping and scattering of the ^{16}O recoil nuclei in the target and backing material. The partial widths of the gamma transitions determined from the present mean-life measurement and the branching and mixing ratios known from other experiments were compared with the predictions of the independent-particle model. Experimental B(E2) values were compared to the calculated B(E2) on the assumption that the 8.88-MeV state forms part of a K = 1 rotational band. (auth)

4223 ABSORPTION OF STOPPED NEGATIVE PIONS. Sakamoto, Y. (Kyoto Univ.). Nucl. Phys., 87: 414-32(1966).

The absorption of stopped negative pions by ^{6}Li, accompanied by the emission of two nucleons, is studied in terms of the direct pion absorption by nucleon pairs. The absorption rates of pions are expressed as a function of the center-of-mass and relative momenta of the nucleon pairs for investigating the momentum distributions of nucleons in the nucleus. The calculated results are compared with experimental data. The data are explained by single-particle harmonic-oscillator functions if the short-range correlation of nucleon pairs is taken into account in the calculation. (auth)

4224 THE ^{19}F(n,n') REACTION AT 14 MeV. Bonazzola, G. C. (Univ., Turin. Istituto Nazionale di Fisica Nucleare, Turin); Chiavassa, E.; Bressani, T. Nucl. Phys., 86: 378-84 (1966).

The differential cross sections for elastic and inelastic scattering of 14.2-MeV neutrons from fluorine were measured in the angular range from 30 to 140° using the time-of-flight technique. Four groups of inelastically scattered neutrons are found at Q = 1.5, 2.8, 4.7, and 5.4 MeV; only the neutron group at 2.8 MeV is due to the excitation of a single level in the fluorine nucleus. (auth)

4225 THE DIRECT EXCHANGE CONTRIBUTIONS TO THE REACTION ^{12}C(α,p)^{15}N BETWEEN 20 MeV AND 40 MeV. Hird, B. (Univ. of Manitoba, Winnipeg). Nucl. Phys., 86: 268-78(1966).

A treatment of the exchange interactions, heavy-particle stripping, and knock-out stripping is developed for (α,p) reactions using plane-wave theory which takes into account interference between the two reaction amplitudes. A comparison with experiment for the reaction ^{12}C(α,p)^{15}N is made. The theory has some success in predicting the angular and the energy positions of the maxima and

minima, but detailed agreement with experiment is rather poor. (auth)

4226 HIGH-ENERGY ELECTRON SCATTERING AS A TEST OF THE NUCLEAR CLUSTER MODEL. Griffy, T. A.; Oakes, R. J.; Schwartz, H. M. (Stanford Univ., Calif.). Nucl. Phys., 86: 313-20(1966).

The possibility of using high-energy electron scattering to investigate the cluster model of light nuclei is discussed. The general formulation of the electron-cluster coincidence cross section for processes of the type A(e,e'b)B is given. Final-state interactions between the ejected cluster and the residual nucleus are taken into account using a square well optical-model potential. Finally, the formalism is applied to the process ^{6}Li(e,e'd)^{4}He as an example. (auth)

4227 ELASTIC AND INELASTIC SCATTERING OF 15.8 MeV DEUTERONS. Cowley, A. A. (Council for Scientific and Industrial Research, Pretoria); Heymann, G.; Keizer, R. L.; Scott, Mary Jean. Nucl. Phys., 86: 363-77(1966).

Absolute differential cross sections were measured for elastic and inelastic scattering of 15.8-MeV deuterons from ^{9}Be, ^{12}C, ^{16}O, ^{27}Al, and ^{32}S. Measurements were taken at angular intervals (lab) of 2.5° ($5° < \theta < 60°$) and 5° ($60° < \theta < 155°$). The angular resolution varied from ±0.1° to ±1.0°. Background was reduced using EΔE coincidences to identify scattered deuterons. The elastic differential cross sections show a marked interference pattern at large angles; at small (cm) angles (9.5° for ^{9}Be and 13.0° for ^{32}S) the cross sections are purely Rutherford. The Blair model, the unified strong absorption model of Frahn and Venter and the optical model were used to analyze the elastic scattering cross sections. (auth)

4228 EFFECTIVE CROSS SECTIONS IN THE PRODUCTION OF ^{7}Be IN VARIOUS ISOTOPES OF NITROGEN, OXYGEN, AND ^{19}F. COMPARISON WITH THE PRODUCTION OF ^{3}Li. Gauvin, Henri (Institut de Physique Nucleaire, Orsay, France). Compt. Rend., Ser. B, 263: 752-4(Sept. 19, 1966). (In French).

The cross sections for the production of ^{7}Be by 156 MeV protons in ^{15}N, ^{16}O, and ^{19}F were measured, thus completing the existing results for ^{14}N and ^{16}O. A regular decrease appeared in proportion to the increase in target mass. A comparison was made with the production of ^{9}Li using these five target nuclei. A qualitative interpretation of the respective processes of formation of these residual nuclei is proposed. (tr-auth)

4229 NEUTRON SPECTRA OF ^{241}Am–^{9}Be SOURCES BY USE OF PROTON RECOILS FROM A SHAPED CONVERTER FOIL. Salgir, T.; Walker, J. (Univ. of Birmingham, Eng.). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-76/39, 15p. (CONF-660807-39). ORAU.

From Symposium on Neutron Monitoring for Radiological Protection, Vienna.

The energy spectra of neutrons from 300-mC and 1-C ^{241}Am–^{9}Be neutron sources were measured by observing protons from a polyethylene converter foil. Proton detectors were of the surface-barrier type and were made from n-type silicon with a sensitive area of 0.28 cm^{2}. Detector pulses were fed to a TMC 1024 multichannel analyzer, and neutron spectra were obtained from the corresponding proton spectra after correcting for the energy dependence of the (n,p) scattering cross section and for the energy relation between protons and neutrons. (S.F.L.)

4230 STUDY OF ELASTIC AND INELASTIC SCATTERING OF 14 MeV NEUTRONS BY ^{6}Li, ^{7}Li, AND ^{9}Be NUCLEI. Merchez, F.; Regis, V.; Nguyen Van Sen; Darves-Blanc, R.; Lien, Pham Dihn; Bouchez, R. (Univ., Grenoble, France. CEN, Grenoble, France). Vienna, International Atomic Energy Agency, 1966, Preprint No. CN-23/75, 8p. (In French). (CONF-661014-26). DTIE.

From IAEA Conference on Nuclear Data, Paris.

The scattering of 14-MeV neutrons on ^{6}Li, ^{7}Li, and ^{9}Be was studied using a simple time-of-flight method (total resolution ≈1 ns). The results were corrected for multiple scattering by a Monte Carlo method. For the ^{6}Li(n,n') scattering the fundamental level and the first 2.18-MeV level were excited, as well as the levels 0^{+} (3.56 MeV), 2^{+} (4.52 MeV), and 5.3 MeV. The differential cross-sections for Q = 0 and Q = −2.18 MeV were measured between 15 and 150° In addition to the doublet $P_{\frac{3}{2}} - P_{\frac{1}{2}}$ and the 4.63-MeV level, for which the angular distributions were measured between 15 and 130°, a study was also made of the group of levels between 6 and 7 MeV for ^{7}Li(n,n') scattering. The existence of the disputed 5.7 MeV level is indicated, and the $\frac{3}{2}^{+}$ level at 6.3 MeV is suggested. Measurements were made of the differential cross sections of elastic scattering from 10 to 140° and inelastic scattering (Q = −2.43 MeV) from 20 to 140° on ^{9}Be. (auth)

4231 THE ^{16}O(n,α)^{13}C REACTION CROSS SECTIONS FROM THE ^{13}C(α,n)^{16}O REACTION. Divatia, A. S.; Sekharan, K. K.; Mehta, M. K. (Atomic Energy Establishment, Trombay, India). Vienna, International Atomic Energy Agency, 1966, Preprint No. CN-23/13, 16p. (CONF-661014-19). DTIE.

From IAEA Conference on Nuclear Data, Paris.

Total cross sections for the ^{16}O(n,α)^{13}C reaction were obtained from the total cross sections for the ^{13}C(α,n)^{16}O reaction, using the principle of reciprocity. The incident neutron energy covered ranges from 3.95 to 6.50 MeV. The ^{13}C(α,n)^{16}O reaction was studied by bombarding an enriched ^{13}C target, about 35 keV thick for 3 MeV alphas, with singly charged He ions obtained from the Trombay Van de Graaff accelerator, in the energy range 1.95 to 5.50 MeV, in steps of 5 to 8 KeV. The total neutron yield was measured by a calibrated 4π neutron detector, consisting of a BF_3-counter, paraffin assembly, and the absolute cross sections were measured to an accuracy of ±15%. About twenty resonances were observed, corresponding to energy levels in the compound nucleus ^{17}O, in the excitation energy region 7.9 to 10.5 MeV. For isolated levels, total widths were deduced. For resonances corresponding to the levels in ^{17}O at 8.40, 8.50, 9.19, 9.50, 9.73, and 9.88 MeV, the ^{16}O(n,α)^{13}C reaction cross sections are 70.8, 132, 43.1, 33.1, 149, and 134 mb, respectively. For these six levels, partial widths for neutron and alpha emission were obtained, using Breit-Wigner dispersion theory. (auth)

Nuclear Properties and Reactions, 20 ≤ A ≤ 89

Refer also to abstracts 3245, 3256, 4193, 4196, 4203, 4205, 4206, 4209, 4212, 4213, 4218, 4227, 4325, 4337, 4346, and 4354.

4232 (AD-628872) ANNUAL PROGRESS REPORT FOR 1965. (Bartol Research Foundation, Swarthmore, Pa.). Mar. 2, 1966. Contract Nonr-3777(00). 22p. CFSTI $1.00 cy, $0.50 mn.

The experimental nuclear physics program concentrated on the application of the resonance fluorescence method to the measurement of the properties of excited states of nuclei, and on preparations for a modification of the Bartol-ONR Van de Graaff which will make it possible to switch from protons to electrons without the need to open the machine. The theoretical investigations were concerned with the isobaric splitting of nuclear dipole states and with the properties of odd-parity states in ^{90}Y and ^{90}Zr. Studies of the variation of the intensity of the nucleonic component of cosmic radiation as a function of altitude and geographic position have continued with the cooperation of the U. S. Naval Oceanographic Office. Data are now available for making a detailed comparison of similar observations conducted at solar maximum and solar minimum. In addition, the primary objectives of the neutron multiplicity experiments have been achieved. (auth)

4233 (AECL-2610) PHYSICS DIVISION PROGRESS REPORT, JANUARY 1–MARCH 31, 1966. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). 57p. (PR-P-69). Dep. mn. AECL $1.50.

A number of energy-level transitions in fluorine were observed by measuring the γ rays emitted following inelastic scattering of 14-MeV neutrons. The 6.02-MeV γ transition from the 7.79-MeV level to the 1.77-MeV level in ^{28}Si was observed following excitation by the ^{25}Mg(α,n)^{28}Si reaction. Gamma decay of the 8.543-MeV level in ^{28}Si was studied from the same reaction. Gamma-ray triple angular correlation measurements were made on levels in ^{26}Si and ^{28}Si to determine spins and multipole mixtures of the radiations. Alpha spectra from the ^{16}O(^{16}O,α)^{28}Si reaction were measured to determine spin-parity combinations for ^{28}Si levels between 7.38 and 8.94 MeV. Gamma-ray spectra corresponding to the de-excitation of 13 levels in ^{24}Mg were analyzed, and the branching ratios to lower levels were determined. Mean lines of 0^{+} states in ^{140}Ce and ^{144}Sm were studied by conversion electron and proton time correlations. Half-life measurements on isomeric ^{127}Xe are reported. Experiments were made using two open-ended cylindrical coaxial Ge(Li) detectors for γ-γ coincidence counting. L-subshell intensity ratios are reported for pure E2 transitions in even-even rare-earth nuclei. A half life of 12.31 ± 0.13 y for ^{3}H was calculated from 5 absolute measurements on AECL ^{3}H standards dating from April 1953 to March 1966. Studies were made of charge collection times in coaxial Ge(Li) spectrometers. Measurements of the magnetic excitations in UO_2 at temperatures close to the antiferromagnetic transition temperature (28.5°K) were made by neutron inelastic scattering techniques. Measurements of the [ξξξ]L branch of the frequency/wave-vector relation of the normal modes of vibration of the alloy $Nb_{0.44}-Mo_{0.56}$ were made on a triple-axis spectrometer. Neutron scattering by liquid K at 73°C was studied using a rotating-crystal spectrometer. No evidence of phonon-like excitations were observed at this temperature. The inelastic scattering of neutrons from phonons in K

at 92°K was measured. Pseudo-potentials were developed for electron–ion interaction in K. Single crystals of $NaNO_2$ were grown by slow cooling of a saturated solution containing a seed crystal. Gamma-ray energies were measured for the reaction $^{199}Hg(n,\gamma)^{200}Hg$ using a coaxial Ge(Li) detector. Similar studies were made for the $^{54}Fe(n,\gamma)^{55}Fe$ reaction using thermal neutrons. Measurements of resonance elastic scattering and self-absorption of γ radiation in natural and radio-lead were performed in the range 5.5 to 8.15 MeV. A technique is described for increasing the efficiency of Ge(Li) detectors, whereby the Compton photons scattered by the Ge crystal are detected by NaI coincidence counters and suitably added to the results. Preliminary results are reported on semiautomatic shell-model calculations for the structure of ^{28}Si. (S.F.L.)

4234 (COO-1120-47) DEUTERON INDUCED REACTIONS ON LIGHT ELEMENTS BELOW 3 MeV. Din, G. U. (Kansas Univ., Lawrence. Nuclear Physics Lab.). Sept. 1, 1966. Contract AT(11-1)-1120. 94p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Excitation functions and angular distributions for the elastic scattering of deuterons and alpha particles from ^{27}Al and angular distributions for the elastic scattering of deuterons from ^{29}Si were measured. Shapes of these functions are in agreement with Rutherford elastic scattering. Differential cross sections for the $^{23}Na(d,p)^{24}Na$, $^{23}Na(d,\alpha)^{21}Ne$, $^{27}Al(d,p)^{28}Al$, $^{27}Al(d,\alpha)^{25}Mg$, $^{29}Si(d,\alpha)^{27}Al$, $^{12}C(d,p)^{13}C$, $^{14}N(d,\alpha)^{12}C$, $^{16}O(d,p)^{17}O$, and $^{16}O(d,\alpha)^{14}N$ reactions to the ground states and some excited states of the residual nuclei were obtained for deuteron bombarding energies between 1.5 and 3.0 MeV. These excitation functions show pronounced structure, to greater extent for the alpha groups than the proton groups. By using targets with thickness corresponding to an energy loss of about 2 keV at a bombarding energy of 2 MeV, a more detailed structure in the yield curves was observed. Angular distributions from 20° to 160° for the proton groups and from 30° to 160° for the alpha groups, taken in steps of 10°, were measured at several deuteron energies from 1.7 to 3.0 MeV. The shape of the angular distributions were found to be strongly energy dependent. (auth)

4235 (IN-1024) NEUTRON ACTIVATION CROSS SECTIONS FOR THE ^{60}Co ISOMERS. Hogg, C. H.; Weber, L. D. (Idaho Nuclear Corp., Idaho Falls). Aug. 1966. Contract AT(10-1)-1230. 12p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

The neutron activation cross sections of the two ^{60}Co isomers were measured relative to that of ^{59}Co with reactor neutrons. The thermal-neutron activation cross section for the 5.27-yr ^{60}Co was measured to be 2.0 ± 0.2 b relative to 37 b for ^{59}Co. The resonance integral was estimated to be 4.3 b relative to 74 b for ^{59}Co. The 10.4-min ^{60m}Co thermal-neutron cross section and the resonance integral are 58 ± 8 b and 230 ± 50 b, respectively, relative to the ^{59}Co values of 37 b and 74 b. The effect of these cross sections on the production of ^{60}Co is small, i.e., 10% during a 3-year irradiation period. (auth)

4236 (ORO-2791-19) ANNUAL PROGRESS REPORT [ON NEUTRON CROSS SECTION PROGRAM] FOR PERIOD ENDING JULY 31, 1966. Morgan, I. L.; Ashe, J. B.; Hall, J. D.; (and others) (Texas Nuclear Corp., Austin). Aug. 15, 1966. Contract AT(40-1)-2791. 181p. Dep. mn. CFSTI $5.00 cy, $1.00 mn.

Separate abstracts were prepared for five sections of the report. (D.C.W.)

For abstracts of individual sections see: 3245, 4237, 4238, 4277, and 4325.

4237 (ORO-2791-19, Paper 1) ANGULAR DISTRIBUTIONS OF GAMMA RAYS PRODUCED IN THE $^{89}Y(n,n'\gamma)^{89}Y$ REACTION. Buchanan, Patricia S.; Mathur, Suresh C.; Tucker, W. E.; Morgan, I. L. (Texas Nuclear Corp., Austin). 34p.

Differential cross sections for gamma production in neutron inelastic scattering by ^{89}Y at 3.0, 3.25, 3.5, 4.0, 4.1, and 4.5 MeV were measured. A number of previously unreported gamma transitions were observed. The angular distributions of the gamma rays were measured at neutron energies of 3.25 and 4.0 MeV; the distributions were also calculated theoretically using the Satchler formalism. Spin assignments were made for a number of levels in ^{89}Y, and evidence for the existence of an excited state at 3.85 MeV was obtained. (D.C.W.)

4238 (ORO-2791-19, Paper 2) THE $(n,n'\gamma)$ REACTION IN ^{54}Fe. Benjamin, R. W.; Morgan, I. L. (Texas Nuclear Corp., Austin). 7p.

Gamma spectra from neutron inelastic scattering by ^{54}Fe at 1.81 to 5.25 MeV were measured, together with angular distributions at 1.81, 3.25, 4.00, and 5.25 MeV. Gamma production cross sections and angular distributions were determined, and information on the energy-level structure of ^{54}Fe was obtained. (D.C.W.)

4239 MASS ESTIMATES OF SHORT RANGE HYPERFRAGMENTS DECAYING NON-MESONICALLY. Bhowmik, B.; Chand, T.; Chopra, D. V. (Univ. of Delhi). pp 700-8 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

Masses of 6 short-range nonmesonic hyperfragments, selected on the basis of high visible energy and large momentum unbalance at the secondary star, were estimated from the decay star analysis. The hyperfragments are found to be in the mass range $20 \leq A \leq 90$. The masses were also estimated from the production star analysis, assuming the validity of the spallation model for the production of such hyperfragments. It is seen that the masses found by both the methods are consistent, thereby justifying the mass determination of short-range hyperfragments from production star analysis. (auth)

4240 AN ESTIMATION OF Λ-NUCLEAR POTENTIAL WELL DEPTH. Bhowmik, B.; Chand, T.; Chopra, D. V. (Univ. of Delhi). pp 709-19 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

An estimate of Λ nuclear potential well depth (D_Λ), from all available experimental results on the Λ binding energies in heavy hyperfragments ($40 \leq A \leq 100$), was made. It is suggested that events having $B_\Lambda \gtrsim 26.5$ MeV involve neutron emission in their decay. The variation in B_Λ for hyperfragment mass 60 to 100 is found to be $\simeq 3.5$ MeV. From the B_Λ's of π−p−r events plotted on a $B_\Lambda - A^{-\frac{1}{3}}$ graph and using exact solution of Schrödinger equation, the value obtained for D_Λ is 37 MeV. (auth)

4241 KINEMATICAL CALCULATION OF Λ-NUCLEON STIMULATION REACTION FOR HYPERFRAGMENTS OF MASS A = 50. Ganguli, S. N.; Swami, M. S. (Tata Inst. of Fundamental Research, Bombay). pp 739-44 of Proceedings of the Ninth Symposium on Cosmic Rays, Elementary Particle Physics, and Astrophysics. Neelakantan, K. A. (ed.). Bombay, Department of Atomic Energy, 1966.

Energy spectra of fast protons ($E \geq 30$ MeV) were calculated for hyperfragments of mass A = 50, from Λ−proton and Λ−neutron stimulation processes respectively. It was concluded, by comparing with experimental energy spectra, that the $\Lambda n/\Lambda p$ stimulation ratio is ~5. It was estimated, from this ratio, that the emission frequencies of two fast protons, from Λ−single nucleon stimulation, both with $E \geq 20$ and ≥ 30 MeV, are ≈3.3 and ≈1.7%, respectively. (auth)

4242 DIRECT NEUTRON CAPTURE IN $^{59}Co(n,\gamma)^{60}Co$. Wasson, O. A.; Bhat, M. R.; Chrien, R. E.; Lone, M. A.; Beer, M. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 17: 1220½(Dec. 12, 1966).

Neutron capture by ^{59}Co was investigated. Evidence for the presence of a direct-capture component in the radiative capture cross section was obtained. (D.C.W.)

4243 EXPERIMENT ON THE TIME-DEPENDENCE OF THE DECAYING STATE. Neuwirth, Wolfgang (Univ., Heidelberg). Z. Phys., 197: 473-504(1966). (In German).

The time dependence of the transmission through a resonating absorber and of the scattering of a resonating scatterer have been investigated using the Mössbauer effect of ^{57}Fe. This seemed useful, because the results of former measurements are not in good agreement with the theoretical prediction and, moreover, there exists a theoretical possibility that these deviations result from a non-Lorentzian energy distribution of the decaying state. The theoretical curves, which will be compared with the experimental results of this work, have been calculated adopting a Lorentzian energy distribution and regarding not only the finite target thickness but also its local variations. Two approximate models have been used for these calculations. The transmission through a thin absorber but with a large absorption cross section can be described within the experimental error of about 2% by an expression which accounts for these local variations. On the other hand, the transmission through a thick absorber with a relatively small absorption cross section can be explained by corrections for a homogeneous absorber. In this case the variations of the thickness are small because of the large geometrical thickness of the absorbing material. The results of the time dependent scattering, too, can be described within the limits of error of about 5% by the correction, regarding finite variations of the thickness of the scatterer. (auth)

4244 INELASTIC ELECTRON SCATTERING FROM LEVELS WITH 7 TO 15 MeV EXCITATION ENERGY IN ^{24}Mg AND ^{26}Mg. Titze, O.; Spamer, E. (Technische Hochschule, Darmstadt, Ger.). Z. Naturforsch., 21a: 1504-6(Sept. 1966).

Energy spectra of electrons scattered inelastically from ^{24}Mg and ^{26}Mg were measured. The electric or magnetic character of 22 transitions was deduced from studies of the angular distributions. Spins, parities, and ground-state radiation widths were determined for levels at 9.97, 10.35, 10.70, and 10.93 MeV in ^{24}Mg. (auth)

4245 INVESTIGATIONS ON ANISOTROPIC SLOWING-DOWN OF LOW-ENERGY MAGNESIUM ATOMS IN A NaCl SINGLE CRYSTAL. Kalus, Juergen (Technische Hochschule, Munich). Z. Naturforsch., 21a: 827-9(June 1966). (In German).

The nuclear resonance fluorescent yield of the 1.37-MeV level of ^{24}Mg that was produced by neutron irradiation of a ^{23}NaCl single crystal was measured as a function of the crystal orientation. Within the measurement accuracy, there was no variation in the yield. Calculations using a hard-sphere model, neglecting the previous β decay for special high-symmetry sites of the ^{24}Mg atom, gave sharp variations in the yield. Possibilities were discussed for explanation of the results. These included the effect of the lifetime of the 4.12-MeV level of ^{24}Mg and the effect of Mg lattice planes of low symmetry. (tr-auth)

4246 GAMMA-GAMMA ANGULAR CORRELATIONS IN THE ^{32}S(n,γ)^{33}S REACTION. Kardon, B.; Kiss, D.; Seres, Z.; Zamori, Z. (Central Research Inst. for Physics, Budapest). Nucl. Phys., A6702: 44-8(1967).

Angular correlation measurements were performed on the 2.97–4.87 MeV and 5.44–3.21 MeV γ cascades observed in the decay of ^{33}S produced by thermal-neutron capture in ^{33}S. The spins of the 5.71- and 3.22-MeV levels were found to be $\frac{1}{2}$ and $\frac{3}{2}$, respectively. (auth)

4247 THE DECAY SCHEMES OF ^{56}Co AND ^{56}Mn AND THEIR USE AS CALIBRATION STANDARDS. Auble, R. L.; McHarris, W. C.; Kelly, W. H. (Michigan State Univ., East Lansing). Nucl. Phys., A6702: 225-37(1967).

The γ rays accompanying the β decays of ^{56}Co and ^{56}Mn were studied using Ge(Li) and NaI(Tl) detectors in singles and in coincidence experiments. Excited states in ^{56}Fe are placed at 846.6 ± 0.5, 2084.8 ± 0.7, 2657.6 ± 0.8, 2960.1 ± 0.8, 3123.7 ± 1.2, 3369.9 ± 0.7, 3445.0 ± 0.7, 3856.2 ± 1.2, 4049.7 ± 0.7, 4101.0 ± 0.7, 4120.7 ± 0.7, 4298.3 ± 0.7 and 4394.2 ± 2.1 keV. The usefulness of the ^{56}Co decay as a γ energy and relative-intensity standard is indicated. (auth)

4248 CALCULATED LEVEL DENSITY OF ^{24}Na. Kanestroem, I. (Univ. of Oslo). Nucl. Phys., A6702: 199-208(1967).

The level density of ^{24}Na as a function of the angular momentum is calculated by employing two different models, an independent-particle system and an SU_3 model with the Elliott quadrupole-quadrupole interaction. The level densities are compared with experimental results. Also the effective moment of inertia and the distribution of the deformation parameter among the nuclear levels are calculated. (auth)

4249 ANALYSIS OF ANALOG-STATE RESONANCES BY COUPLED OPTICAL EQUATIONS. Auerbach, E. H. (Massachusetts Inst. of Tech., Cambridge); Dover, C. B.; Kerman, A. K.; Lemmer, R. H.; Schwarcz, E. H. (Contract AT(30-1)-2098. Phys. Rev. Lett., 17: 1184-6(Dec. 5, 1966).

Resonances due to the excitation of states in ^{89}Y corresponding to the $d_{\frac{3}{2}}$, $s_{\frac{1}{2}}$, and $d_{\frac{5}{2}}$ states in ^{89}Sr were previously observed in proton scattering by ^{88}Sr at 4 to 8 MeV. An analysis of the data using a pair of coupled optical-model equations to describe the nucleon–nucleus interaction is outlined. (D.C.W.)

4250 SOME CONSIDERATIONS ON THE EXPERIMENTAL ASPECT OF THE INTERACTIONS OF 25-GeV/c PROTONS (AND 5-GeV/c ANTIPROTONS) WITH Br AND Ag NUCLEI IN NUCLEAR EMULSIONS. I. RESULTS RELATING TO THE DISTRIBUTIONS OF THE DIFFERENT MAGNITUDES CONCERNING THE PARENT STARS. Stein, R. (Centre de Recherches Nucleaires, Strasbourg). J. Phys. (Paris), 27: 405-10(July-Aug. 1966). (In French).

In the course of a study of fragment ($3 \leq Z \leq 8$) emission induced by 25-GeV/c protons in nuclear emulsion, a phenomenological study was made of the stars emitting the fragments. The results were compared with results obtained for stars induced by 25 GeV/c protons and 5-GeV/c antiprotons without fragment emission. (D.C.W.)

4251 ON THE ^{20}Ne(n,2α)^{13}C REACTION. Petralia, S. (Istituto Nazionale di Fisica Nucleare, Bologna); Di Caporiacco, G; Mando, M.; Parrini, G. Nuovo Cimento (10), 44B: 225-8(July 11, 1966).

About 800 three-prong events were observed in a study of the ^{20}Ne(n,α)^{17}O reaction at 14.2 MeV. An analysis of the data indicated that the events were due to the reaction ^{20}Ne(n,2α)^{13}C. (D.C.W.)

4252 THE ACTIVATION CROSS SECTION OF ^{30}Si FOR THERMAL NEUTRONS. Koehler, W.; Knopf, K. (Technische Hochschule, Munich). Z. Naturforsch., 21a: 829-30(June 1966). (In German).

By simultaneous activation of Au and Si in the water reflector of a reactor, the effective cross section of the reaction ^{30}Si(n,γ)^{31}Si for thermal neutrons was measured to be 103 ± 3 mb. (tr-auth)

4253 ENERGY LEVELS OF ^{38}Ca FROM THE REACTION ^{40}Ca(p,t)^{38}Ca. Hardy, J. C.; Skyrme, D. J.; Towner, I. S. (Nuclear Physics Lab., Oxford). Phys. Lett., 23: 487-90(Nov. 21, 1966).

From the reaction ^{40}Ca(p,t)^{38}Ca, energy levels in ^{38}Ca were observed, and spins and parities were assigned. The results are discussed with reference to configuration mixing in the ^{40}Ca ground state and shell-model calculations for ^{38}Ca. (auth)

4254 THE DECAY OF ^{48}Sc AND ^{48}V. Konijn, J.; Lingeman, E. W. A.; De Wit, S. A. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Nucl. Phys., 6701A: 558-72(1967).

The decays of ^{48}Sc and ^{48}V were studied with Ge(Li) diodes, scintillation spectrometers and a double-focusing beta spectrometer. The 3507-keV level, from which originates the quadruple cascade (9.4 ± 0.5%) in the ^{48}Sc decay, is also de-excited by a 1212-keV cross-over transition to the 2295-keV (4^+) level and supports the assumption that the 3507-keV level has a spin 6^+. The first member of the reported triple cascade in the ^{48}V decay is shown to be a doublet of 928.9 ± 0.7 (1.2 ± 0.2%) and 944.3 ± 0.5-keV (8.0 ± 0.5%) gamma rays, both followed by the 1311.4–983.3 keV cascade. Evidence was found that the 2421-keV (2^+) level is excited by weak gamma rays from high-energy levels. The K/β^+ ratio in the ^{48}V decay is 0.69 ± 0.05. The Q-values of ^{48}Sc and ^{48}V are calculated to be 3986 ± 7 keV and 4015 ± 4 keV, respectively. The energy of the gamma ray of ^{47}Sc, which is present as an impurity, is 159.2 ± 0.5 keV. (auth)

4255 ENERGY LEVELS OF ^{82}Kr POPULATED BY ^{82}Br DECAY. Raman, Subramanian (Pennsylvania State Univ., University Park). Nucl. Phys., 6701A: 508-22(1967).

The γ rays following the β decay of ^{82}Br were investigated using a 220-mm^3 Ge(Li) detector, an anti-Compton NaI(Tl) spectrometer and a two-dimensional coincidence arrangement. The ^{82}Br was produced by thermal-neutron activation of ammonium bromide. The presence of eight, well-known and 11 weak γ rays was established. It was shown through half-life measurements that the newly identified γ rays belong to ^{82}Br decay and that the high-energy peaks are not due to summing effects. All the reported transitions were incorporated in a level scheme of ^{82}Kr by introducing levels at 0, 776, 1474, 1820, 1953, 2093, 2426, 2554, 2647 and 2828 keV. Limits on probable spin and parity values for the newly introduced levels were established. The level introduced at 2828 keV on the basis of a 1008 to 1043 keV γ-γ coincidence must be fed by a weak β branch of ^{82}Br with an end-point energy of 263 keV and log ft of approximately 6.1. (auth)

4256 THE FERMI MATRIX ELEMENTS INFERRED FROM β-γ (CP) CORRELATION MEASUREMENTS IN ^{59}Fe DECAY. Tirsell, K. Glenn; Mann, L. G. (Univ. of California, Livermore). Nucl. Phys., 6701A: 657-64(1967). (UCRL-14679).

Measurements were made of the β-γ circular-polarization correlation parameter A for the 273-keV β branch in the decay of ^{59}Fe. It was recently established that each of the principal β branches of ^{59}Fe involves $\Delta J = 0$ and thus has a possible non-zero Fermi matrix element M_F which can be determined from the ft value and A. Previous β-γ (CP) measurements on this nuclide have all employed the usual γ-ray scattering technique. This method is suitable for the 475-keV β branch but does not produce an accurate measurement of the lower-energy branch because of energy discrimination difficulties. A transmission polarimeter with γ discrimination was used to obtain clean data on the 273-keV β-1.29-MeV γ cascade. Calibration with ^{60}Co (1.33 MeV) and ^{28}Al(1.79 MeV) yielded $A = -0.154 \pm 0.023$. This gives for the isospin impurity coefficient and the effective Coulomb matrix element of the 1.29-MeV state $(1.1 \pm 1.4) \times 10^{-3}$ and 9 ± 11 keV, respectively. (auth)

4257 THE ^{39}K(^{3}He,p)^{41}Ca REACTION AT 13.0 MeV. Belote, T. A.; Dao, Fu Tak; Dorenbusch, W. E.; Kuperus, J.; Rapaport, J. (Massachusetts Inst. of Tech., Cambridge). Phys. Lett., 23: 480-2(Nov. 21, 1966).

The ^{39}K(^{3}He,p)^{41}Ca reaction was investigated at a bombarding energy of 13.0 MeV. The predominant mode of excitation was found to be L = 0 deuteron transfer. The results show the two-particle, one-hole character of the low-lying even-parity states in ^{41}Ca, as well as for other levels situated at higher energies. (auth)

4258 AN ISOMER OF HIGH SPIN AND ENERGY IN ^{53}Fe. Eskola, K. (Univ. of Helsinki). Phys. Lett., 23: 471-3(Nov. 21, 1966).

A decay scheme for a 2.5-min 3.04-MeV isomeric state of ^{53}Fe is proposed. It is suggested that the isomeric state is a three-particle state, the two proton holes and the neutron hole in the $f_{\frac{7}{2}}$ shell having been coupled to their maximum spin value $^{19}/_2^-$. (auth)

4259 CROSS SECTIONS FOR THE $^{63}Cu(n,\alpha)^{60}Co$, $^{60}Ni(n,p)^{60}Co$, AND SOME OTHER THRESHOLD REACTIONS USING NEUTRONS FROM THE $^{9}Be(\alpha,n)^{12}C$ REACTION. Liskien, H.; Paulsen, A. (EURATOM, Geel, Belg.). Nukleonik, 8: 315-19(Aug. 1966).

Using the activation method cross sections relative to the well-known n–p scattering cross section were determined for the reactions $^{24}Mg(n,p)^{24}Na$, $^{27}Al(n,\alpha)^{24}Na$, $^{56}Fe(n,p)^{56}Mn$, $^{59}Co(n,\alpha)^{56}Mn$, $^{60}Ni(n,p)^{60}Co$, and $^{63}Cu(n,\alpha)^{60}Co$ in the energy range 6.0 to 8.3 MeV. For the last two reactions average cross sections for fission neutrons were calculated and compared with literature values. Neutrons from the ground-state transition of the $^{9}Be(\alpha,n)^{12}C$ reaction produced by means of a 3 MeV Van de Graaff accelerator were used. Angular distributions at E_α = (2.50 ± 0.18) MeV and (2.65 ± 0.27) MeV were measured. (auth)

4260 HYPERFINE STRUCTURE, NUCLEAR MOMENTS, AND ISOTOPE SHIFTS OF ^{197}Tl AND ^{198}Tl. Davis, Sumner P.; Kleiman, Herbert; Goorvitch, David; Aung, Tin (Univ. of California, Berkeley). J. Opt. Soc. Amer., 56: 1604-7(Nov. 1966).

The hyperfine structure of ^{197}Tl was derived from an analysis of two lines in the optical spectrum observed under high resolution. The magnetic dipole interaction constants are $A(^2S_{\frac{1}{2}})$ = 394 ± 3 mK and $A(^2P_{\frac{1}{2}})$ = 691 ± 4 mK. The dipole moment of ^{197}Tl calculated from the ratio of hyperfine splittings is $\mu_I(197)$ = 1.55 ± 0.02 nm. The hyperfine structure of ^{198}Tl was not resolved. Isotope shifts measured with respect to ^{205}Tl were found to be Δ (197 – 205) = –234 ± 4 mK and Δ (198 – 205) = –229 ± 4 mK in the 5350-Å line and Δ (197 – 205) = –210 ± 4 mK and Δ (198 – 205) = –209 ± 4 mK in the 3776-Å line. (auth)

4261 INELASTIC SCATTERING OF 185-MeV PROTONS FROM Mg AND Al. Dahlgren, S.; Hasselgren, D.; Hoeistad, B.; Ingemarsson, A.; Johansson, A.; Renberg, P.-U.; Sundberg, O.; Tibell, G. (Uppsala Univ.). Nucl. Phys., 6701A: 673-95(1967).

A magnetic spectrometer was used for the energy analysis of protons scattered from targets of magnesium (natural isotopic composition) and aluminum. The mean energy of the incident protons in the targets was 185 MeV. A total energy resolution of 350 keV (FWHM) was achieved, which made possible the observation of the excitation of a large number of discrete levels. Energy spectra were measured in the angular region of 4 to 40° (lab system). The results are presented partly in the form of tables giving measured excitation energies and maximum cross sections for resolved levels and partly in the form of graphs of angular distributions of the differential cross sections. A qualitative discussion of the results is given in terms of the multipolarities of the transitions involved, and comparisons are made with similar results from other experiments in inelastic scattering and in a few cases with theoretical predictions. (auth)

4262 THE (d,n) REACTION ON ^{24}Mg AND ^{28}Si. Buccino, S. G.; Gemmell, D. S.; Lee, L. L. Jr.; Schiffer, J. P.; Smith, A. B. (Argonne National Lab., Ill.). Nucl. Phys., 86: 353-62(1966).

The reactions $^{24}Mg(d,n)^{25}Al$ and $^{28}Si(d,n)^{29}P$ were studied. The J-dependent effects similar to those observed in (d,p) reactions were seen. Pronounced differences in neutron distributions resulting from l_p = 2 transitions to the 1.36($\frac{3}{2}^+$) and 1.96($\frac{5}{2}^+$) MeV states in ^{29}P and to the ground state ($\frac{5}{2}^+$) and 0.95-MeV state ($\frac{3}{2}^+$) in ^{25}Al were noted. These differences were observed at incident deuteron energies of 7.0, 9.0 and 10.0 MeV. The data were analyzed by use of DWBA calculations and spectroscopic factors obtained for most of the above transitions. The results are compared with structure in the mirror nuclei ^{25}Mg and ^{29}Si. (auth)

4263 J-DEPENDENCE IN THE $^{56}Fe(p,d)^{55}Fe$ REACTION. Whitten, C. A. Jr.; Kashy, E.; Schiffer, J. P. (Princeton Univ., N. J.). Nucl. Phys., 86: 307-12(1966). (PUC-937-212).

The dependence of (p,d) angular distributions on the total angular momentum J of the picked-up neutron was investigated in the $^{56}Fe(p,d)^{55}Fe$ and the $^{60}Ni(p,d)^{59}Ni$ reactions with 17.5-MeV protons. The differences in the angular distributions between $p_{\frac{1}{2}}$ and $p_{\frac{3}{2}}$ neutron pickup and between $f_{\frac{5}{2}}$ and $f_{\frac{7}{2}}$ neutron pickup are consistent with those found in the (d,p) stripping reaction. (auth)

4264 THE DECAY OF ^{51}Mn. Glibert, K. M.; Easterday, H. T. (Oregon State Univ., Corvallis). Nucl. Phys., 86: 279-88(1966).

The half life of ^{51}Mn produced by the $^{50}Cr(d,n)$ reaction was measured to be 46.5 ± 0.2 min. The end-point energy for the positron decaying to the ground state of ^{51}Cr was established to be 2.21 ± 0.02 MeV while weak branching to the 761- and 1170-keV levels of ^{51}Cr was inferred from the 761 ± 11 keV and 1170 ± 15 keV gamma rays observed in the ^{51}Mn gamma spectrum. Relative intensities for these weak gamma rays were experimentally determined to be 0.70 ± 0.10 and 0.48 ± 0.12% of the positrons, respectively. A 10.8 ± 0.8-nsec mean life was obtained for the 761-keV level of ^{51}Cr while an upper limit of 1 nsec was given to the 1170-keV level. Spin assignments, along with log ft values and branching intensities, are also discussed for these levels. (auth)

4265 STUDY OF THE REACTIONS $^{22}Ne(d,p)^{23}Ne$ AND $^{22}Ne(d,\alpha)^{20}F$ AT 2 MeV. Lambert, Michel; Dumazet, Gerard; Beaumevieille, Henri (Institut d'Etudes Nucleaires, Alger, Algeria). Compt. Rend., Ser. B, 263: 513-16(Aug. 17, 1966). (In French).

The effective absolute differential cross sections of the reactions $^{22}Ne(d,p)$ and $^{22}Ne(d,\alpha)$ were studied at 2 Mev for the p_0, p_1, and p_4 groups and for α_0, α_1, α_3, and α_4. The determination of the angular momentum transfer of the captured neutron gave the values l_n = 2, 0, and 2 for the groups p_0, p_1, and p_4, respectively. (tr-auth)

4266 COMPOUND-STATISTICAL FEATURES OF DEUTERON-INDUCED REACTIONS. I. RADIATIVE CAPTURE OF 4 TO 15 MeV DEUTERONS. Pement, F. W.; Wolke, R. L. (Univ. of Pittsburgh). Nucl. Phys., 86: 417-28(1966). (NYO-2771-16).

Absolute cross sections and excitation functions for the $^{30}Si(d,\gamma)^{32}P$ and $^{138}Ba(d,\gamma)^{140}La$ reactions from ≈4 to 15 MeV were measured radiochemically using the stacked target technique. The $^{30}Si(d,\gamma)$ cross sections above 5 MeV are 110 to 160 μb and exhibit little energy dependence. The $^{138}Ba(d,\gamma)$ excitation function peaks at ≈22 μb near 10 MeV. The compound nucleus mechanism, formulated from continuum-theory cross sections and statistical-model calculations using Fermi gas level densities, reproduces both the magnitudes and the dissimilar energy dependences of the two excitation functions. Inverse E1 photonuclear cross sections were calculated both for the giant resonance shape used by Carver and Jones and for that proposed by Lane and Lynn, the former providing more satisfactory agreement with experiment, especially in the Si reaction. It is concluded that these radiative deuteron capture reactions can be explained in terms of compound-nucleus formation followed by statistical de-excitation. (auth)

4267 MEASUREMENT OF CROSS SECTIONS AND RESONANCE ABSORPTION INTEGRALS BY THE OSCILLATION METHOD. Carre, J. C.; Vidal, R. (CEN, Fontenay-aux-Roses, France). Vienna, International Atomic Energy Agency, 1966, Preprint No. CN-23/74, 24p. (In French). (CONF-661014-15). DTIE.

From IAEA Conference on Nuclear Data, Paris.

The phase oscillation method was used to measure the thermal-neutron absorption cross sections of materials with small capture cross sections but with large scattering cross sections. The technique permits attenuation of the diffusion effect by a large factor with a measuring point located in the reflector, i.e., in a well-thermalized medium. Thermal absorption cross sections were obtained at 2200 m/s for Al, Co, Cu, Fe, Mg, Mo, and Zr. The conventional amplitude oscillation method was used at the MINERVE reactor to measure the reaction rates produced by small samples. The measurements were made at the center of the core, without a cadmium filter, in a spectrum with a high percentage of epithermal neutrons. By deducting the thermal part, the resonance integrals were derived from the measured cross section by calibration with reference to gold. Resonance integrals were measured for Ag, Cu, Co, Cs, Fe, Hf, In, Mn, Mo, Ni, Th, and Zr. For cases in which the resonance parameters were known with sufficient accuracy, the measured values were compared with those calculated or measured elsewhere. (S.F.L.)

4268 INELASTIC SCATTERING OF FAST NEUTRONS FROM ^{58}Ni AND ^{60}Ni. Towle, J. H.; Batchelor, R.; Gilboy, W. B. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Vienna, International Atomic Energy Agency, 1966, Preprint No. CN-23/35, 8p. (CONF-661014-32). DTIE.

From IAEA Conference on Nuclear Data, Paris.

The Aldermaston time-of-flight spectrometer was used to study neutron scattering from ^{58}Ni and ^{60}Ni with monoenergetic T(p,n) neutrons in the energy range 1.3 to 4.0 MeV. In order to obtain detailed information on the energy levels of these nuclei, 30-g samples of the separated isotopes (>99% pure) were used. The natural isotopic abundances of ^{58}Ni and ^{60}Ni are 67.8 and 26.2% respectively. The data on ^{60}Ni were obtained with a beam pulsed by deflection in the high-voltage terminal of the 6-MV Van de Graaff machine giving a mean target current of 0.7 μA. The ^{58}Ni measurements were made after klystron bunching had been installed in the high voltage terminal, and the increased target current (~2.5 μA was used) greatly enhanced the rate of data acquisition and offset the disadvantage of a small scattering sample. Angular distributions were measured between 20 and 135° at incident energies of 2, 3, and 4 MeV. The cross sections are relative to the well-known H(n,n) cross sections and were corrected for multiple scattering and flux attenuation using the Monte Carlo program MAGGIE. The cms angular distributions of the inelastic groups are practically symmetric about 90° in agreement with the statistical model of the

compound nucleus. Relative excitation curves were also measured at 0.2 MeV intervals at 125° and were normalized to the cross sections obtained at 2 and 3 MeV. The curves for the strongly excited 2+ levels of ^{58}Ni and ^{60}Ni at 1.45 and 1.33 MeV, respectively, were continued at 0.1-MeV intervals down to threshold by observing the γ peak in the time-of-flight spectrum. There are some large disagreements between the present results for these levels and the data obtained by Broder et al. and Nishimura et al. using NaI spectrometers. The excitation curve of the 1.45-MeV ^{58}Ni level has a broad resonance at about 2.6 MeV. Inelastic scattering cross sections were calculated using a Hauser-Feshbach computer program with width-fluctuation correction and are compared with the experimental results. (auth)

4269 NEUTRON INELASTIC SCATTERING FROM ^{56}Fe. Barnard, E.; de Villiers, J. A. M.; Reitman, D. (Atomic Energy Board, Pelindaba, South Africa). Vienna, International Atomic Energy Agency, 1966, Preprint No. CN-23/86, 10p. (CONF-661014-8). DTIE.

From IAEA Conference on Nuclear Data, Paris.

Previous measurements of the cross section for excitation of the 845-keV level in ^{56}Fe close to threshold were made by detecting the gamma rays following inelastic neutron scattering. These results indicated severe structure over the first 250 keV above threshold. In order to determine whether the same effects would also show up in measurements on the inelastically scattered neutrons, a ^{10}B + NaI detector was constructed. Using this detector and time-of-flight techniques to resolve the inelastically scattered neutrons, measurements were made down to an incident neutron energy of 893 keV. Excellent agreement was found between the two types of measurement over the entire region of overlap. Since the structure in the excitation curve appeared to persist toward higher energies, measurements were extended as far as 1500-keV incident energy. At the higher energies, a conventional plastic scintillator was employed. Where both neutron detectors were used at the same energies, very good agreement was found. All measurements were done with a 3-MeV pulsed Van de Graaff and the ^{7}Li(p,n) reaction as neutron source. Targets were between 5- and 15-keV thickness and pulse lengths of either 3 or 10 nanoseconds were used, depending on the resolution required. Flight paths varied between 1 and 3 meters. Absolute cross sections were obtained by using elastic scattering from carbon as a standard. Flux attenuation and multiple scattering corrections were calculated at several representative energies by means of a Monte Carlo method. These corrections were found to be small. The excitation curve was measured from 893 to 1500 keV at intervals of approximately 10 keV for a scattering angle of 90°. A number of strong resonances were observed, many of which had not been previously recorded. Angular distributions were measured at several of the more prominent peaks and valleys. No systematic variation was, however, obtained. The angular distributions would thus seem unable to shed any mcre light on the origin of the sharp resonances. (auth)

4270 RADIATIVE CAPTURE OF FAST NEUTRONS BY THE NUCLEI ^{26}Mg, ^{55}Mn, ^{63}Cu, ^{87}Rb, ^{89}Y, AND ^{193}Ir IN THE 0.15 TO 7 MeV ENERGY RANGE. Tolstikov, V. A.; Koroleva, V. P.; Kolesov, V. E.; Dovbenko, A. G. (Inst. of Physics and Energetics, Obninsk, USSR). Vienna, International Atomic Energy Agency, 1966, Preprint No. CN-23/103, 6p. (In Russian). (CONF-661014-31). DTIE.

From IAEA Conference on Nuclear Data, Paris.

The radiative capture cross sections of ^{26}Mg, ^{55}Mn, ^{63}Cu, ^{87}Rb, ^{89}Y, and ^{193}Ir were measured by the activation method in the 0.15 to 7 MeV energy range. As neutron source the reactions T(p,n) and D(d,n) were obtained with a Van de Graaff accelerator. The neutron flux was monitored by fission chambers with layers of ^{235}U, and the induced β activity was measured by end-window β counters. As reference cross sections the fast and thermal fission cross sections of ^{235}U and the radiative capture cross sections of the nuclei of these isotopes for thermal neutrons were used. The results obtained are compared with the results of other authors and with calculations made according to the statistical theory of nuclear reactions. In calculating the penetration factors for the nuclear surface the optical model of the nucleus with a diffuse edge was used and account was taken of spin-orbit coupling. (auth)

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Refer also to abstracts 3245, 4190, 4196, 4203, 4205, 4212, 4213, 4233, 4236, 4240, 4250, 4266, 4267, 4270, 4325, 4345–4347, 4354, 4356, and 4371.

4271 (AD-632579) MOESSBAUER SCATTERING IN ^{195}Pt. [PART] I. Atac, M.; Debrunner, P.; Frauenfelder, H. (Illinois Univ., Urbana. Dept. of Physics). 1966. Contract Nonr-1834(05). 15p. CFSTI $1.00 cy, $0.50 mn.

The Moessbauer effect of the 99 keV transition in ^{195}Pt was studied in a backscattering geometry. From the partially resolved Zeeman pattern observed with platinum in iron, cobalt, and nickel, the g-factor of the excited state, $g^{3}/_{2} = -0.43 + 0.10$, and the internal fields were determined. (auth)

4272 (AD-641746) DISINTEGRATION OF ^{113}Sn. Bosch, H. E.; Simon, M. C.; Szichman, E.; Gatto, L.; Abecasis, S. M. (Instituto de Investigacione Aeronautica y Espacial, Buenos Aires (Argentina)). July 1966. 30p. CFSTI $2.00 cy, $0.50 mn.

A re-investigation of the decay of 119-d ^{113}Sn was carried out with scintillation as well as with lithium-drifted silicon and germanium detectors. In addition to x rays, two gamma rays of 0.2555 ± 0.0005 and 0.3910 ± 0.0005 MeV were found in relative intensity $(2.9 \pm 0.3) \times 10^{-2}$. The K-conversion coefficient of the 0.2555-MeV transition was measured to be 0.042 ± 0.010 and that of the 0.3910-MeV transition, 0.49 ± 0.04 (K/LM = 4.2 ± 0.4). The electron-capture ratio P_{EC} (LM. . .)/P_{EC} (K) to the 0.6465-MeV level of ^{113}In was determined to be 0.36 ± 0.20. The bremsstrahlung end-point energy to the same level was (0.080 ± 0.005) MeV. From these values the decay-energy transitions to that level were deduced to be 0.050 to 0.170 MeV and (0.110 ± 0.005) MeV, respectively. A decay scheme is constructed and reasonable shell-model as well as microscopic model assignments are made to all levels. (auth)

4273 (GA-7391) DOPPLER BROADENING OF THE ^{235}U FISSION CROSS SECTION: COMPARISON OF NUMERICAL TREATMENT WITH CONVENTIONAL SINGLE LEVEL ANALYSIS. Cohen, S. C. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Sept. 28, 1966. Contract AT(04-3)-167. 49p. (CONF-661019-4). Dep. mn. CFSTI $2.00 cy, $0.50 mn.

From International Conference on Fast Critical Experiments and Their Analysis, Argonne, Ill.

The ^{235}U cross section data of Michaudon were Doppler-broadened numerically, and the results were compared with the conventional single-level treatment using a consistent set of level parameters derived by Drawbaugh and Gibson. The analysis was carried out in the energy interval 2.38 to 29.03 eV, in which 38 resonance levels have been resolved. The purpose of the investigation was to examine the feasibility of the numerical treatment and to obtain a quantitative estimate of the deviation between the results of the two methods of analysis for a consistent set of level parameters and experimental data. The total and fission cross section data for ^{235}U were extracted from the SCISRS library. The data were Doppler-broadened numerically to 1500 and 2500°K using a version of the TEMPO code revised to operate on the IBM-7044 computer. The code numerically evaluates the Doppler-broadened cross section $\sqrt{E}\,\sigma(E,T) = \int_{-\infty}^{\infty} dE'\,\sqrt{E'}\,\sigma(E',T')\,\kappa(E',T';E,T)$, where $\kappa(E',T';E,T) = K_{\alpha}(E',E,T\text{-}T_{eff})$, the conventional Maxwellian kernel. The experimental resolution was taken into account by defining an effective temperature: $T_{eff} = T' + T^{R}$, where T^{R} follows from an assumed Gaussian resolution function. Effective self-shielded fission cross sections were obtained at the two temperatures for homogeneous mixtures of uranium–oxygen and uranium–hydrogen. Moderators to uranium ratios typical to fast reactors and extending into the near thermal region were considered. The results indicate a deviation in $\Delta\sigma_f$ between the single-level and numerical treatment of less than 20% if each set of cross sections is used to compute the appropriate spectrum, and less than 10% if only the spectrum obtained from the numerical data is used. (auth)

4274 (GEMP-448) EVALUATION AND COMPILATION OF ^{181}Ta, ^{182}W, ^{183}W, ^{184}W, AND ^{186}W CROSS SECTION DATA FOR THE ENDF/B FILE. Henderson, W. B.; DeCorrevont, P. A.; Zwick, J. W. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). Nov. 11, 1966. Contract AT(40-1)-2847. 91p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Evaluated neutron cross section data are given for ^{181}Ta, ^{182}W, ^{183}W, ^{184}W, and ^{186}W. The resolved resonance range is specified to extend upward from 10^{-6} eV to the point at half the level spacing above the last resolved resonance. The lower limit was picked to ensure that at room temperature, and above, errors of the order of 1% or less would be incurred by neglecting reactions below the cutoff. The single-level Breit–Wigner formula for s-wave neutrons was used in a code to compute point value and integral cross sections. No Doppler broadening or solid-state effects were included. No attempt was made to compensate for inadequacy of the single-level formula by smooth cross sections. A single negative energy level was used in each isotope to improve the fit to measured absorption and total cross sections in the thermal range. The values assigned are regarded as preliminary. (S.F.L.)

4275 (JINR-P-2910) NOVYE IZOTOPY ^{176}Re I ^{175}Re. (New Isotopes ^{176}Re and ^{175}Re). Nadzhakov, E.; Nenov, N.; Zaitseva,

N. G.; Pfrepper, G.; Khristov, D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1966. 8p. Dep. mn.

New isotopes ^{176}Re and ^{175}Re were obtained when bombarding Ho targets with ^{16}O ions and Tb targets with ^{22}Ne ions. They were identified by the genetic connection with the W and Ta daughter isotopes, as well as by some rotational ^{176}W levels known from the reaction. The half lives are determined to be (5 ± 1 min) for ^{176}Re and (5 ± 1 min) for ^{175}Re. (auth)

4276 (LA-DC-7851) MEASUREMENT OF AVERAGE CROSS-SECTION RATIOS IN FUNDAMENTAL FAST-NEUTRON SPECTRA. Grundl, J. A.; Hansen, G. E. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1966]. Contract W-7405-eng-36. 20p. (CONF-661014-4). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From IAEA Conference on Nuclear Data, Paris, France.

Spectral indices (energy-sensitive average cross-section ratios) are presented for the fast neutron spectra at the center of bare and natural-uranium-reflected spheres of ^{239}Pu, ^{233}U, and ^{235}U. By means of energy-sensitive nuclear reactions, the six fast critical assembly spectra are compared (1) among themselves, (2) to corresponding fission-neutron spectra, and (3) to neutrons of a single energy. Experimental errors depend upon reproducibility of detecting systems, spectral distortions due to the presence of detecting systems, and purity of the monoenergetic and fission neutrons. Recommended excitation functions and estimated uncertainties are presented for each detector reaction in coarse group structures for computational checks. The observed spectral indices and detector excitations, together with their uncertainties, provide a set of values that must be met by the microscopic cross sections ^{239}Pu, ^{233}U, and ^{235}U via transport computation. (S.F.L.)

4277 (ORO-2791-19, pp 32-74) NEUTRON CROSS SECTION MEASUREMENTS. (Texas Nuclear Corp., Austin).

Gamma spectra from neutron bombardment of ^{239}Pu, ^{235}U, and ^{238}U at 1.09, 2.1, 3.0, 4.0, 5.0, and 14.8 MeV were measured at several angles; gamma production cross sections were obtained. Gamma spectra and angular distributions from the ^{10}B(n,α)^{7}Li reaction at 0.545 to 4.0 MeV and at 14.8 MeV were also measured; differential and integrated cross sections for the 0.478-MeV gamma ray were obtained. Additionally, gamma cross sections for neutron inelastic scattering by Nb at 1.0, 1.5, 1.7, 2.1, 3.5, 4.0, and 14.8 MeV were measured; preliminary theoretical calculations of the gamma cross sections were made using the TRANSEC code. Gamma spectra from neutron inelastic scattering by natural Ce at 1.5 to 4.5 MeV and at 14.8 MeV were also measured. (D.C.W.)

4278 (TID-23396) MULTILEVEL ANALYSIS OF THE ^{235}U TOTAL AND FISSION CROSS SECTIONS IN THE ENERGY REGION BELOW 37 ev. Final Report. Adler, D. B.; Adler, Felix T. (Chicago Univ., Ill. Dept. of Physics). Aug. 1966. Contract AT(11-1)-1546. 86p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

For Brookhaven National Lab., Upton, N. Y.

A method was developed for representing the neutron cross sections of the fissionable elements in the resonance region below 37 eV. The method is based on the multilevel–multichannel formalism which is recast into a generalized Kapur–Peierls expansion, and formulas are developed which express the cross sections as superpositions of interfering Breit–Wigner lines. The parameters defining resonance energy and the coefficients of the symmetrical and asymmetrical line shape functions characterizing each level are derived using the multilevel cross section formulas by a least squares analysis of the experimental data. (S.F.L.)

4279 OCTUPOLE VIBRATIONS OF DEFORMED NUCLEI. Donner, W.; Greiner, W. (Univ., Frankfurt am Main). Z. Phys., 197: 440-72(1966).

The octupole vibrations of deformed nuclei are studied. A strong coupling between the harmonic octupole vibrations and the quadrupole ellipsoid is assumed. This interaction gives rise to a splitting of octupole bands with different projection quantum number K. The E1-transitions of the octupole states are explained within the frame of the dynamic collective theory of Danos and Greiner by calculating the Coulomb interaction between octupole vibrations and giant resonances. Furthermore, the E2- and E3- transitions of the octupole states are studied. The spectrum of ^{182}W is investigated in detail. A fair agreement between theory and experiment is obtained. Predictions for the octupole spectra of ^{152}Sm and ^{156}Gd are given. (auth)

4280 A SIMPLE METHOD FOR DETERMINATION OF NUCLEAR LIFETIMES IN THE REGION 10 TO 100 DAYS AND ITS APPLICATION TO THE DECAY OF ^{181}Hf. Broman, L.; Karlsson, K. (Chalmers Univ. of Tech., Goteborg). Nucl. Instrum. Methods, 44: 174(Sept. 1966).

A radioactive source containing ^{181}Hf and ^{137}Cs of equal strength was prepared and γ spectra obtained at different times during a six-week interval. The intensity of the 0.48-MeV γ rays from the decay of ^{181}Hf and the 0.66-MeV γ rays from the decay of ^{137}Cs were compared in the γ spectra, and the ratio of intensity of the photopeaks was assumed to obey the relation $I_{0.48}/I_{0.66} = \exp[(\lambda_{Cs} - \lambda_{Hf})/T]$, where T is the running time. Since λ_{Cs} is very small (about 7.4×10^{-10}/sec) compared with λ_{Hf} (about 1.9×10^{-7}/sec), not even a fairly large error in λ_{Cs} will affect the λ_{Hf} value. Using the measured γ-ray intensities, it is thus possible to obtain a very accurate value of $T_{\frac{1}{2}}$ for ^{181}Hf. The value obtained was $T_{\frac{1}{2}}$ for ^{181}Hf = 42.29 ± 0.10 days. (S.F.L.)

4281 ELASTIC SCATTERING OF ELECTRONS AND POSITRONS BY SCREENED NUCLEI. Zeitler, Elmar (Armed Forces Inst. of Pathology, Washington, D. C.); Olsen, Haakon. Z. Naturforsch., 21a: 1321-7(Sept. 1966).

Results of calculations of cross sections for elastic electron and positron scattering are given in angular steps of 15° for elements Z = 6, 13, 29, 50, 82, and 92 and energies T = 0.2, 0.4, 0.7, 1, 2, 4, and 10 MeV. The calculation is based on the separability of the cross section into two factors, one describing screening and the other spin and relativistic effects. The first factor is obtained by the Molière approximation. The second factor is taken from a paper by Doggett and Spencer [Phys. Rev. 103: 1597(1956)]. Different screening potentials for Z = 29 were applied. (auth)

4282 THE K-, L-, AND M-AUGER AND L-COSTER–KRONIG SPECTRA OF PLATINUM. Toburen, L. H.; Albridge, R. G. (Vanderbilt Univ., Nashville). Nucl. Phys., 6701A: 529-44 (1967).

The K-, L- and M-Auger and L-Coster-Kronig spectra of platinum in the electron capture decay of ^{195}Au was measured using an iron-free, double-focusing spectrometer. The energies and relative intensities of 55 peaks were measured in the L-Auger spectrum in the energy range of 5 to 12 keV. The intensities are compared to those calculated theoretically for silver by Asaad. The total L-Coster-Kronig plus M-Auger intensity (0 to 3.25 keV) was measured relative to the L-Auger intensity. The measured relative intensities of the KLL-Auger lines are compared with theoretical and experimental results. The measured KLL energies agree with those calculated semi-theoretically by Hörnfeldt and by Listengarten. A value of KLX/KLL = 0.548 ± 0.044 was measured. A measurement of the $KL_3L_3(^3P_0)/KL_3L_3(^3P_0 + {}^3P_2)$ ratio, the first reported in this Z-region, gave a value of 0.095 ± 0.024. (auth)

4283 AUGER-VACANCY SATELLITES IN THE DECAY OF $_{82}^{210}$Pb (RaD). Haynes, S. K. (Michigan State Univ., Lansing. Instituut voor Kernphysisch Onderzoek, Amsterdam); Velinsky, M.; Velinsky, L. J. Nucl. Phys., 6701A: 573-92(1967).

The L-Auger spectrum of ^{210}Bi from RaD (^{210}Pb) was studied with a resolution of 0.18% and a very thin source but with some sacrifice in statistics. A total of 66 lines or line groups were wholly or partially identified. The L_3-MM lines, most of which result from filling L_3 vacancies created by the $L_1-L_3M_{4,5}$ Coster-Kronig process, are displaced an average of −36 ± 5 eV with respect to the energies expected from the $L_{1,2}$–MM spectra. This effect is the Auger analog of the phenomenon of x-ray satellites. The $L_3-M_4M_5$ and $L_3-M_5M_5$ displacements agree within experimental error with predictions from the displacements of the strongest $L\alpha_1$ and $L\alpha_2$ x-ray satellites. The term Auger-vacancy satellites is suggested for these displaced Auger lines to distinguish them from the weak lines of the K–LL spectrum for which the term Auger intermediate-coupling satellites is suggested. The ratio $(L_1-M_4M_5$ Auger Line$)/L_1$ vacancies = R = 32.5 ± 3.5, which may have importance in determining L_1 capture as distinct from L-capture, was also measured for the first time. The endpoint of the low-energy beta spectrum of ^{210}Pb was found to be 17.0 ± 0.5 keV. (auth)

4284 RANGE DISTRIBUTION OF FISSION PRODUCTS IN SOLIDS. Selig, Otmar; Sizmann, R. (Technische Hochschule, Munich. Univ., Munich). Nukleonik, 8: 303-14(Aug. 1966). (In German).

The range distribution of the ^{235}U and fission products ^{95}Zr (97 MeV) and ^{140}Ba (165 MeV) was measured in mica by the transmission method and in aluminum by means of electrochemical peeling. The most probable ranges of these nuclides in mica are 12 and 9.4×10^4 Å, and in polycrystalline aluminum 15.2 and 11.1×10^4 Å, respectively (half-width 14 and 17.5%, respectively). Channeling is found in Al single crystals, particularly if the particle direction is in ⟨110⟩, less if in ⟨111⟩ orientation. An effective aperture of 1.9° (+0.4°; −0.6°) can be calculated for the 110 direction from experiments with varied distance between the emitter (2500 Å ^{235}U films) and the crystal surface. (auth)

4285 THE SPIN OF ^{228}Ac FROM BETA-DECAY EXPERIMENTS. Bhattacherjee, S. K.; Mitra, S. K.; Jain, H. C.; Padhi, H. C.; Bhatki, K. S.; Ephraim, D. C. (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys., 6701A: 696-704(1967).

The spin of the odd nucleus ^{228}Ac ($T_{½}$ = 6.13 h) was determined to be I = 3 from the beta circularly polarized gamma correlation studies on two prominent beta-gamma cascades: the 1.19-MeV beta group (966 and 908) keV gamma rays and the 1.76-MeV beta group (338-keV gamma rays). The matrix element ratio X for the 1.76-MeV beta transition was determined to be X = 0.40 ± 0.10. (auth)

4286 NUCLEAR ORIENTATION OF ^{109m}Ag NUCLEI IN IRON. Cracknell, M. F.; Wilson, G. V. H. (Oxford Univ.). Phys. Lett., 23: 306-7(Oct. 31, 1966).

Measurements are reported of the anisotropy of γ radiation from ^{109m}Ag nuclei polarized in an iron host at about 0.014°K. The deduced value for the magnitude of the hyperfine field at silver nuclei in iron is 336 ± 20 kOe. (auth)

4287 SEARCH FOR POSITONS IN THE DECAY OF ^{143}Pm, ^{144}Pm, AND ^{146}Pm. Varga, D. (Inst. of Nuclear Research, Academy of Sciences, Debrecen, Hungary); Berenyi, D.; Ujhelyi, Cs.; Molnar, F. Nucl. Phys., A6702: 157-63(1967).

A coincidence method was used for detecting annihilation radiation in the search for positons in the decay of ^{143}Pm, ^{144}Pm, and ^{146}Pm. The activities of these three isotopes contained in the source were determined from an analysis of the gamma spectrum. The source was obtained by chromatographic separation from Ta, Er, and Gd targets irradiated by 660 to 680 MeV protons. The number of positons per decay was determined to be $<1.0 \times 10^{-6}$ for ^{143}Pm, $<2.0 \times 10^{-5}$ for ^{144}Pm, and $<1.2 \times 10^{-4}$ for ^{146}Pm. These limits are lower by several orders of magnitude for the first two nucleides than previously published data. No data have been published for ^{146}Pm. From these values the upper limits for the total disintegration energies are 1122, 2635, and 1982 keV for ^{143}Pm, ^{144}Pm and ^{146}Pm, respectively. (auth)

4288 ANISOTROPIC β DECAY AFTER ABSORPTION OF POLARIZED NEUTRONS ON INDIUM. Rauch, H. (Oesterreichische Hochschule, Vienna). Z. Phys., 197: 389-408(1966). (In German).

The anisotropic β decay of ^{116}In(14-sec) nuclei, which were polarized by means of polarized neutron absorption, is described. The anisotropy on InF_3, In_2O_3, InP and In metal at room temperature, 77°K, 4.2°K and different magnetic-field strengths was measured. Based on the magnitude of the anisotropy and its time dependence, it was possible to make predictions concerning nuclear spins, nuclear moments, and relaxation phenomena of ^{116}In. It was possible to measure by means of this method the nuclear lattice relaxation time of the short-lived β-active ^{116}In(14-sec) nuclei in the different compounds with a great sensitivity. (auth)

4289 DELAYED COINCIDENCE MEASUREMENTS FROM ^{183}Ta AND ^{183}Re DECAY. Meiling, W.; Stary, F.; Andrejtscheff, W. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Nucl. Phys., A6702: 49-63(1967). (In German).

The lifetime of the 453-keV level ⁹/₂⁻[503] in ^{183}W was measured using a multi-parameter time analyzer. From the decay of ^{183}Ta and ^{183}Re with different energy selections a mean value of $T_{½}$ = 18.0 ± 0.5 nsec was found. From delayed γγ coincidences in 16 energy combinations and the excitation spectrum of the 453-keV level, the existence of a ⁹/₂, ½⁻[503] level is confirmed. The results are discussed in terms of band mixing effects. The log ft values show some disagreements especially in connection with the 1½⁺[615] level. (auth)

4290 BRANCHING RATIOS AND CONVERSION COEFFICIENTS OF EXCITED STATES OF ^{209}Tl. Ilgen, Karl (Technische Hochschule, Stuttgart). Z. Phys., 197: 328-42(1966). (In German).

The branching ratios of the γ rays of the second and fourth excited states of ^{209}Tl were investigated by coincidence measurements between the α rays of ^{212}Bi and subsequent 40-keV γ rays. The detectors employed were a silicon surface-barrier counter for α particles, and a 1.5 in. × 2 mm NaJ(Tl) crystal for γ rays. It was found that 75.6 ± 3.7% of all transitions of the 328-keV state and 94 ± 7% of all transitions of the 492 keV + 473 keV states populate the first excited state of ^{209}Tl. The 40-keV state is excited to 3.4 ± 0.3% by transitions of higher excited states relative to the direct excitation by α particles. The number of α particles with energy E_α = 6.047 MeV and the number of subsequent 40 keV γ rays resulted in a conversion coefficient α(40 keV) = 22.55 ± 0.46. Similarly coincidence measurements between Tl x rays and α particles were used to determine the K-conversion coefficients α_K(328 keV) = 0.31 ± 0.03 and α_K(492 keV + 473 keV) = 0.100 ± 0.015. The experimental results are in good agreement with the theoretical values of Sliv. (auth)

4291 ON A SUPPOSEDLY ANOMALOUS LOG FT VALUE IN ^{114}In DECAY. Blasi, P.; Maurenzig, P. R.; Taccetti, N. (Univ., Florence. Istituto Nazionale di Fisica Nucleare, Florence). Nuovo Cimento (10), 44B: 222-4(July 11, 1966).

The γ decay of ^{114m}In was investigated. An upper limit of 0.025% was obtained for the intensity of the transition from the ^{114}In ground state to the 1210-keV level of ^{114}Cd; the log ft of the transition is at least 4.3, in contrast to a previously reported value of 3.3, which is perfectly normal for an allowed transition. (D.C.W.)

4292 THE LEVELS OF ^{165}Tm POPULATED BY THE DECAY OF ^{165}Yb. Paris, Pierre (Centre de Spectrometrie Nucleaire, Orsay, France). Compt. Rend., Ser. B, 263: 656-9(Sept. 5, 1966). (In French).

The experimentally observed transitions of the decay ^{165}Yb → ^{165}Tm are discussed. A partial level scheme is proposed. The energies of the intrinsic levels admitted in this scheme fall normally into a system which includes the four known neutron-deficient thulium isotopes and agrees with the corresponding Nilsson diagram. (tr-auth)

4293 STUDY OF THE ISOMER OF ^{208}Bi. Monnand, Edouard; Pinston, Jean-Alain (CEN, Grenoble, France). Compt. Rend., Ser. B, 712-15(Sept. 12, 1966). (In French).

The 2.6-msec isomer of ^{209}Bi from the reaction ^{209}Bi(n,2n)^{208m}Bi at 14.3 MeV was investigated using γ spectrometry. The cross section of the reaction was measured to be 290 ± 30 mbarns. A 630-keV transition was identified in the de-excitation spectrum of ^{208m}Bi. A decay scheme is proposed for ^{208m}Bi. (D.C.W.)

4294 AGREEMENTS BETWEEN THE INTERNAL CONVERSION COEFFICIENTS OF THE L AND M SUBLEVELS IN THE PURE E2 TRANSITION OF ^{171}Yb AT 75.88 keV. Gizon, Jean; Jourdan, Alfred (CEN, Grenoble, France). Compt. Rend., Ser. B, 625-8(Aug. 29, 1966). (In French).

The L and M conversion electrons of the E2 transition of isotopically separated ^{171}Yb at 75.88 keV were studied using a $\pi\sqrt{2}$ spectrometer with a 50 cm width. The results obtained are: $L_I/L_{II}/L_{III}$ = 69/935/1000 and $M_{II}/M_{III}/M_{IV} + M_V$ = 979/1000/27. (tr-auth)

4295 ANALYSIS OF GROUPS OF CONVERSION ELECTRONS IN THE M SHELL. Gizon, A. (Centre d'Etudes Nucleaires, Grenoble, France). J. Phys. (Paris), 27: 411-14 (July-Aug. 1966). (In French).

Conversion electrons of 25.6-keV and 48.9-keV transitions in ^{161}Dy and of the 58.5-keV transition in ^{231}Pa were measured with a iron-free double-focusing spectrometer. The multipole order of these transitions are determined from L conversion lines. Spectra of M conversion electrons are compared with conversion coefficients tabulated by Rose and with theoretical coefficients including the screening corrections suggested by Chu and Perlman. (auth)

4296 THE EFFECT OF CONVERTER THICKNESS ON THE f-FACTOR USED IN THE IEC METHOD. Zender, M. J.; Albridge, R. G. (Vanderbilt Univ., Nashville). Nucl. Phys., A6702: 112-22(1967).

The effect of converter thickness on the f-factor used in the internal-external conversion method was investigated for a particular geometry at energies of 300, 340, 364, and 412 keV and with seven different converters with thicknesses ranging from 0.39 to 3.71 mg/cm². The known K-shell conversion coefficients of the 364-keV transition in ^{131}Xe and the 412-keV transition in ^{198}Hg were used to calculate f. The experimental results differ greatly from scatter-corrected calculations of f. (auth)

4297 ENERGY DISTRIBUTION OF PHOTONEUTRONS FROM Bi AND Pb. De Marco, A.; Garfagnini, R.; Piragino, G. (Univ., Turin. Istituto Nazionale di Fisica Nucleare, Turin). Nuovo Cimento (10), 44B: 172-7(July 11, 1966).

The energy spectra of photoneutrons from Bi and Pb irradiated with 80-MeV bremsstrahlung γ rays was studied at an angle of 135° by means of a diffusion cloud chamber filled with helium. The experimental energy spectra were analyzed with the formula given by Le Couteur and Lang for the evaporative processes at high excitation energies. (auth)

4298 REACTIONS (p,α × n) AND (p,pα × n) ON BISMUTH AT MEDIUM ENERGIES: PRESUMPTIONS IN FAVOR OF THE PROJECTION OF ALPHA SUBSTRUCTURES. Bimbot, Rene; Lefort, Marc (Univ., Paris, Orsay, France). J. Phys. (Paris), 27: 385-97(July-Aug. 1966). (In French).

Cross sections for the production of Pb nuclei and Tl nuclei in proton reactions with Bi at 30 to 140 MeV were measured. In the energy range from 30 to 90 Mev, the mechanism for the production of these nuclei can be described as a knock-out of α clusters by either primary protons or secondary prompt nucleons, followed by the de-excitation of the residual nuclei through neutron evaporation. Evidence in favor of the hypothesis of α substructure in the diffuse region of nuclear matter on the surface of heavy nuclei was obtained. (D.C.W.)

4299 STUDY OF THE ^{123}Te(n,α)^{120}Sn REACTION WITH THERMAL NEUTRONS. Cheifetz, E.; Gozez, Y.; Yavin, A. I. Atomic

Energy Commission, Yavne, Israel). Nucl. Phys., A6702: 238-40 (1967).

The ^{123}Te (n,α)^{120}Sn reaction induced by thermal neutrons was investigated. The observed cross section for the transition to the ground state of ^{120}Sn was 15 ± 10 μb. The smallness of the cross section suggests that the first neutron resonance at 2.36 eV in ^{123}Te has a spin and parity 1$^+$. The measured Q-value for the reaction is 7.50 ± 0.10 MeV. An upper limit of 50 μb is set for the (n,α') reaction leading to the first excited state of ^{120}Sn. (auth)

4300 PRECESSION MEASUREMENTS FOLLOWING COULOMB EXCITATION WITH OXYGEN IONS. II. GYROMAGNETIC RATIOS OF THE 2$^+$ STATES IN Hf, W, AND Os ISOTOPES. Gilad, P.; Goldring, G.; Herber, R.; Kalish, R. (Weizmann Inst. of Science, Rehovoth, Israel). Nucl. Phys., A6702: 85-96 (1967).

Gyromagnetic ratios were measured by a method described previously for the 2$^+$ rotational states in ^{178}Hf, ^{180}Hf, ^{186}W and ^{186}Os. Previous measurements on other osmium isotopes were revised in the light of recent life time measurements. A general survey is presented for the g-factors in even hafnium, tungsten, and osmium isotopes. A general treatment of angular distributions in ring counter geometry is given. (auth)

4301 RESULTS ON THE CROSS SECTION OF ^{238}U FISSION INDUCED BY LOW-ENERGY MONOENERGETIC γ RAYS. Manfredini, A. (Istituto Nazionale di Fisica Nucleare, Rome. Univ., Rome); Muchnik, M.; Fiore, L.; Ramorino, C.; De Carvalho, H. G.; Boesch, R.; Woelfli, W. Nuovo Cimento (10), 44B: 218-21(July 11, 1966).

The results of a measurement of the photofission cross section of ^{238}U at twelve energies between 5 and 9 MeV are presented. (D.C.W.)

4302 FISSION-FRAGMENT ANGULAR ANISOTROPY IN THE REACTIONS ^{235}U(d,pf) AND ^{239}Pu(d,pf). Specht, H. J.; Fraser, J. S.; Milton, J. C. D. (Chalk River Nuclear Labs., Ont.). Phys. Rev. Lett., 17: 1187-90(Dec. 5, 1966).

The angular anisotropy of fission fragments from the reactions ^{239}Pu(d,pf) and ^{235}U (d,pf) was investigated as a function of the excitation energy of the compound nucleus. (D.C.W.)

4303 THE K CONVERSION COEFFICIENTS AND THE INTENSITIES OF THE TRANSITIONS IN ^{189}Ir. Fourrier, Alain; Jastrzebski, Jerzy; Paris, Pierre; Kilcher, Pierrette; Treherne, Jacqueline (Institut de Physique Nucleaire, Orsay, France). Compt. Rend., Ser. B, 263: 509-12(Aug. 17, 1966). (In French).

The intensity of gamma transitions in the decay ^{189}Pt → ^{189}Ir was determined using Ge(Li) detectors. The conversion coefficients, α_K, and the total intensities of the transitions were calculated. (tr-auth)

4304 ROTATIONAL OPTICAL MODEL ANALYSIS OF FAST NEUTRON SCATTERING BY ^{232}Th NUCLEUS. Baldoni, B.; Benzi, V. (CNEN, Bologna). 5p. of Evaluation of Neutron Cross-Section Data. Paris, European Nuclear Energy Agency, [1965].

Angular distributions and cross sections for neutron scattering by ^{232}Th were fitted using a rotational-optical model. The results indicate that, for strongly deformed nuclei, the direct coupling between the incident particle motion and the nuclear surface rotation can not be neglected. (D.C.W.)

4305 MEASUREMENT OF FISSIONS PRODUCED IN BULK ^{239}Pu BY 4 eV to 20 keV NEUTRONS. Czirr, J. B.; Bramblett, R. L. (Univ. of California, Livermore). 2p. of Evaluation of Neutron Cross-Section Data. Paris, European Nuclear Energy Agency, [1965]. (UCRL-14153).

Average fission cross sections, average total cross sections, and self-shielding factors were determined for ^{239}Pu in 11 energy groups over the energy range from 4.64 eV to 21.5 keV. (D.C.W.)

4306 DECAY OF ^{163}Ho. Funke, L.; Graber, H.; Kaun, K.-H.; Sodan, H. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Nucl. Phys., 86: 345-52(1966). (In German).

The γ spectrum from the decay of ^{163}Ho was measured using a Ge(Li) detector and a two-dimensional scintillation coincidence device. The sources were produced by the irradiation of Er_2O_3 (97% ^{170}Er) with the bremsstrahlung of a betatron. Levels in ^{163}Er with the following energies were found: 65, 75, and 222 keV (ground-state rotational band 1/2$^-$[521]) and 850 and 920 keV (5/2$^-$[523] band). (auth)

4307 THE LEVEL STRUCTURE OF THE NUCLEUS ^{140}Ce. Baer, H. W.; Reidy, J. J.; Wiedenbeck, M. L. (Univ. of Michigan, Ann Arbor). Nucl. Phys., 86: 332-44(1966). (COO-1112-31).

Precision energy measurements on 24 gamma lines in the ^{140}La → ^{140}Ce decay were performed with a 2-m curved-crystal spectrometer and a lithium-drifted germanium spectrometer. The relative intensities of 15 gamma rays were determined. A level scheme for ^{140}Ce is proposed with the inclusion of two new levels at 2516.14 and 2547.5 keV. The level scheme is compared with recent calculations using the quasi-particle description. (auth)

4308 EXCITED STATES OF ^{171}Yb FED IN THE ELECTRON CAPTURE DECAY OF ^{171}Lu. Kaye, Geoffrey (Chalk River Nuclear Labs., Ont.). Nucl. Phys., 86: 241-67(1966).

Sources of ^{171}Lu were produced by the reaction ^{172}Yb(p,2n)^{171}Lu at 14 MeV. The excited states of ^{171}Yb fed by the electron capture decay of ^{171}Lu was investigated using the Chalk River high-resolution β spectrometer at a resolution of 0.2% and 0.06%, germanium lithium-drifted γ counters and e-γ coincidence techniques. Conversion lines corresponding to 24 transitions in ^{171}Yb were observed with energies in keV; 9.150, 19.384, 27.126, 46.516, 55.679, 66.718, 72.365, 75.872, 85.59, 91.39, 109.27, 154.72, 163.81, 194.88, 517.7, 627.9, 667.3, 689.3, 712.6, 739.7, 767.5, 780.6, 840.0 and 853.0. The multipolarities of the transitions below 200 keV were determined from measured L sub-shell conversion intensity ratios and for the higher-energy transitions from measured K-conversion coefficients. From a comparison of the experimental data with the Nilsson model the following states were assigned single-particle orbitals K$^\pi$[Nn$_z\Lambda$]; the ground state 1/2$^-$[521], 95.26 keV 7/2$^+$[633], 122.39 keV 5/2$^-$[512], 834.9 keV 7/2$^-$[514] and 935.2 keV 9/2$^+$[624]. (auth)

4309 COMPOUND-STATISTICAL FEATURES OF DEUTERON-INDUCED REACTIONS. II. THE COMPOUND NUCLEUS AND STRIPPING-EVAPORATION MECHANISMS IN (d,2n) REACTIONS. Pement, F. W.; Wolke, R. L. (Univ. of Pittsburgh). Nucl. Phys., 86: 429-42(1966). (NYO-2771-17).

Six excitation functions for (d,2n) reactions on ^{65}Cu, ^{126}Te, ^{128}Te, ^{130}Te, ^{133}Cs, and ^{186}W were measured radiochemically between ≈4 and 15 MeV. The excitation functions exhibit sharp rises above threshold and peak near the (d,3n) thresholds at values approaching the cross sections for compound nucleus formation. The present results are included with previous data in a theoretical analysis covering the mass region above A = 47. Calculations of the excitation functions were performed for two different mechanisms; compound-nucleus formation followed by the evaporation of two neutrons and (d,n) stripping followed by the evaporation of one neutron. The compound-statistical model generally accounts very well for both the magnitudes and the energy dependences of the cross sections. The predictions of the stripping-evaporation mechanism are 15–30% of the observed cross sections. It is concluded that the compound-nuclear mechanism predominates in (d,2n) reactions above A = 47. (auth)

4310 ROTATIONAL LEVELS POPULATED BY INELASTIC DEUTERON SCATTERING. Elbek, B.; Kregar, M.; Vedelsby, P. (Univ. of Copenhagen). Nucl. Phys., 86: 385-94(1966).

The cross sections for inelastic deuteron scattering to rotational states of doubly-even nuclei in the rare-earth region were measured at a deuteron energy of 12 MeV and a scattering angle of 125°. The population of the 4$^+$ states is considerably less regular than expected from the observed population of the 2$^+$ states. This is taken as an indication for a direct E4 transition to these states. The estimated maximum hexadecapole deformation parameter β_4 is about 0.09. (auth)

4311 EFFECTIVE NUCLEAR MOMENTS IN ^{207}Pb. Koerner, H. J.; Auerbach, K.; Braunsfurth, J.; Gerdau, E. (Univ., Hamburg). Nucl. Phys., 86: 395-404(1966).

The magnetic moment of the 570-keV state in ^{207}Pb was measured by perturbed angular correlations to be +0.65 ± 0.05 nm. This value corresponds to an effective g-factor $g_{s,eff}$ = (0.48 ± 0.04) $g_{s,free}$ for the $f_{\frac{5}{2}}$ neutron-hole state. The experimental result is discussed in terms of the core polarization mechanism. The half life of the $f_{\frac{5}{2}}$ state was determined to be 129 ± 3 psec. The effective charge of the $f_{\frac{5}{2}}-p_{\frac{3}{2}}$ transition is calculated to be 0.93 ± 0.03. An upper limit of 40 psec was derived for the half life of the 894-keV $p_{\frac{3}{2}}$ level. (auth)

4312 TWO-QUASI-PARTICLE STATES AT 1095 keV AND 1543 keV IN ^{168}Er. Jursik, J.; Zvolska, V. (Inst. for Nuclear Research, Czechoslovak Academy of Sciences, Rez). Nucl. Phys., 86: 405-16(1966).

The gamma spectrum of ^{168}Tm was studied by means of Ge(Li) detectors. The multipolarities of transitions in ^{168}Er were determined. The spin and parity of the 1095- and 1543-keV levels were determined to be 4$^-$ and 3$^-$, respectively. By the delayed-coincidence method, the half life of the 1095-keV level was found to be 1.07 ± 0.10 × 10^{-7} sec. The structure of the 1095- and 1543-keV two-quasi-particle states is discussed. (auth)

4313 INTERNAL CONVERSION COEFFICIENT OF THE 81-keV TRANSITION IN ^{133}Cs. Subba Rao, B. N. (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys., 86: 443-8(1966).

From a determination of the 358-keV $\gamma \rightarrow$ 81-keV γ coincidence rate, the total conversion coefficient is determined to be 1.76 ± 0.03, and the K-conversion coefficient is deduced to be 1.44 ± 0.03. The nuclear structure effect parameter is calculated to be +1 ± 1. (auth)

4314 ANGULAR DISTRIBUTIONS FOR INELASTIC DEUTERON SCATTERING FROM SAMARIUM. Zeidman, B.; Elbek, B.; Herskind, B.; Olesen, M. C. (Univ. of Copenhagen). Nucl. Phys., 86: 471-80(1966).

The elastic and inelastic scattering of 12-MeV deuterons from targets of ^{148}Sm, ^{150}Sm, ^{152}Sm, and ^{154}Sm was investigated. Angular distributions for the elastic group and for the more prominent inelastic groups were measured by means of solid-state counters. Supplementary information was obtained from high-resolution magnetic spectrograph data. The elastic angular distributions are smooth and without diffraction structure. The absolute cross section at back angles decreases with increasing mass number. This effect can probably be ascribed to differences in the inelastic excitations since the distributions for the sum of elastic and inelastic intensity are almost identical for all the nuclei. The shape of the angular distributions for the collective 2^+, 4^+ and, when observed, for the 6^+ levels, for each angular momentum is very similar in all the nuclei, although the character of the levels changes from vibrational to pure rotational. The same is true for the distributions of the strongly excited 3^- levels. It is thus indicated that the angular distributions give a simple determination of the multipolarity of the excitation, the tendency being a decrease in forward-backward ratio with increasing multipolarity. (auth)

4315 SPARK CHAMBER MEASUREMENT OF NEUTRON FISSION CROSS SECTIONS AND RELATED PARAMETERS. Bowman, Charles D.; Auchampaugh, George F. (Univ. of California, Livermore). Vienna, International Atomic Energy Agency, 1966, Preprint No. CN-23/38, 14p. (CONF-661014-13). DTIE.

From IAEA Conference on Nuclear Data, Paris.

The use of spark chambers for measurement of the nuclear properties of short-lived isotopes such as ^{241}Am, ^{242}Am, ^{244}Cm, ^{238}Pu, and ^{232}U is described. The usefulness and limitations of the technique are illustrated by measurements on $^{242\,m}$Am from 0.02 eV to 6 MeV obtained with a 50-mg Am sample containing about 20% $^{242\,m}$Am and 80% ^{241}Am. Other uses of spark chambers in measuring $\bar{\nu}$, α, and spontaneous fission half lives are presented. (S.F.L.)

4316 NEUTRON SPECTRA AND ANGULAR DISTRIBUTION PRODUCED BY 1 Gev PROTONS ON A THICK LEAD TARGET. Fraser, J. S. (Atomic Energy of Canada Ltd., Chalk River, Ont.); Hewitt, J. S.; Walker, J. 9p. (CONF-660639-3). ORAU. Gmelin, AED-CONF-66-221-4.

From Congress-Canadian Association of Physicists, Sherbrooke, Quebec.

A time-of-flight technique was used to measure the energy spectra of neutrons at 45°, 90°, and 135° produced by a pulsed beam of 1-GeV protons on a thick (30 cm) lead target. The measurements were found to agree with predictions based on Monte Carlo calculations of the experiment. (S.F.L.)

4317 PILE NEUTRON CAPTURE CROSS SECTIONS OF RARE EARTH ISOTOPES. Dobrozemsky, R.; Formann, E.; Lugmair, G.; Pichlmayer, F.; Viehboeck, F. P.; Wotke, H. (Reactor Center, Seibersdorf, Austria). Vienna, International Atomic Energy Agency, 1966, Preprint No. CN-23/82. 12p. (CONF-661014-20). DTIE.

From IAEA Conference on Nuclear Data, Paris.

Cross sections were determined by measuring isotopic ratios before and after irradiation. The relative change of the isotopic ratio, and hence the accuracy of the result, is higher the better the enrichment of the isotope in question before irradiation. Since the enrichment of commercially available isotopes is insufficient, separated isotopes were prepared using the Seibersdorf inhomogeneous magnetic field isotope separator. Oxides were used as ion source charge material and were vaporized by the chlorination method. To obtain optimum focusing conditions, the positions of the accelerating electrodes are adjustable during operation. The isotopes were collected in water-cooled graphite or aluminium pockets. After chemical processing, the isotopic ratios were determined by mass spectrometry. In a one-step separation, ^{156}Gd enriched to 99%, ^{154}Gd to 89%, ^{170}Yb to 96%, and the heavier Yb isotopes to 99% were obtained. The samples were irradiated together with a cobalt flux monitor, with and without Co shielding. Afterwards the isotopic ratios were determined again. Cross-section data are given. (auth)

4318 NEUTRON-SPECTROSCOPIC INVESTIGATION OF SEPARATED SILVER ISOTOPES. Muradyan, G. V.; Adamchuk, Yu. V. (Kurchatov Inst. of Atomic Energy, Moscow). Vienna, International Atomic Energy Agency, 1966, Preprint No. CN-23/107, 24p. (In Russian). (CONF-661014-27). DTIE.

From IAEA Conference on Nuclear Data, Paris.

The results are presented of measurements on the radiative capture of neutrons in the separated silver isotopes ^{107}Ag and ^{109}Ag in an energy range up to 1000 eV. A number of previously unreported levels were found. It is shown that the marked discrepancy between the level-spacing distribution previously reported for Ag and the Wigner distribution for various superposed level systems is only apparent. It is also shown that there is no correlation between ^{107}Ag and ^{109}Ag levels within the limits of statistical accuracy obtained. The values of the strength functions S_0 for ^{107}Ag and ^{109}Ag are found to be 0.43×10^{-4} and 0.83×10^{-4}, respectively. This marked difference in the strength function values of nuclei of almost the same atomic weight is not consistent with the optical model of the nucleus and can probably be explained on the hypothesis of compound-nucleus formation through three-quasi-particle interactions. (auth)

4319 FINE STRUCTURE OF THE ENERGY DEPENDENCE OF $\bar{\nu}$ FOR ^{233}U AND ^{235}U IN FISSION INDUCED BY NEUTRONS OF LESS THAN 1 MeV. Kuznetsov, V. F.; Smirenkin, G. N. (Inst. of Physics and Energetics, Obninsk, USSR). Vienna, International Atomic Energy, 1966, Preprint No. CN-23/97. 16p. (In Russian). (CONF-661014-25). DTIE.

From IAEA Conference on Nuclear Data, Paris.

The results are given of comparative measurements of the average number of secondary neutrons for ^{233}U and ^{235}U in the energy range of fission-inducing neutrons up to 1 MeV. The results of the comparative measurements were converted to absolute values on the basis of the relation: $\bar{\nu}(E_n) = \bar{\nu}_{th} + a(E_n - \Delta\bar{E}_n)$ where $\bar{\nu}(E_n)$ and $\bar{\nu}_{th}$ are, respectively, the mean number of secondary neutrons for any primary-neutron energy E_n and for thermal energy, a is a parameter inverse to the mean energy of neutron emission, and $\Delta\bar{E}_n$ is the difference between the mean kinetic energy of fragments in the case of fission induced by neutrons of energy E_n and by thermal neutrons. Use of this relation is based on the fact that, within the limits of the neutron energy range studied, a change in the mass yield curve and the energy removed by neutrons and fission gamma rays have no pronounced effect on the redistribution of energy between the collective and internal degrees of freedom of the fissioning nucleus. The feasibility of this indirect method of arriving at absolute figures was corroborated by deriving the absolute values for ^{235}U directly. Interpretations of the results are presented. (auth)

4320 MEASUREMENTS OF THE FISSION CROSS SECTIONS OF ^{239}Pu AND ^{241}Pu RELATIVE TO THAT OF ^{235}U IN THE NEUTRON ENERGY RANGE 0.016 TO 0.55 eV. White, P. H.; Reichelt, J. M. A.; Warner, G. P. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Vienna, International Atomic Energy Agency, 1966, Preprint No. CN-23/58, 24p. (CONF-661014-34). DTIE.

From IAEA Conference on Nuclear Data, Paris.

Measurements were made to an accuracy of ±2% of the ratios of the fission cross sections of ^{239}Pu and ^{241}Pu to that of ^{235}U in the energy range 0.016 to 0.55 eV and also in two thermalized fields of neutrons. The monoenergetic neutrons were obtained from a crystal spectrometer on the AWRE reactor HERALD. At the three lowest neutron energies, a velocity selector was used to remove neutrons diffracted into the second and higher orders. At the other energies resonance filters were used. One thermal neutron field was an extracted beam from the graphite thermal column; its spectrum was measured by a time-of-flight method. The other thermal neutron field was in a cavity inside the thermal column. Some discrepancies between the present results and previous measurements are discussed. Corrections and errors due to the neutron spectra of both the monoenergetic neutrons and the thermal beam and errors introduced by beam non-uniformity are described. (auth)

4321 HARWELL MASS SPECTROMETRIC MEASUREMENTS OF THE RATIO OF NEUTRON CAPTURE TO FISSION FOR ^{233}U, ^{235}U, ^{239}Pu, AND ^{241}Pu, IN REACTOR AND MAXWELLIAN NEUTRON SPECTRA. Cabell, M. J. (Atomic Energy Research Establishment, Harwell, Eng.). Vienna, International Atomic Energy Agency, 1966, Preprint No. CN-23/21, 24p. (CONF-661014-14). DTIE.

From IAEA Conference on Nuclear Data, Paris.

Use of the mass-spectrometric method for the measurement of α, the ratio of neutron capture to fission, for the four nuclides ^{233}U, ^{235}U, ^{239}Pu, and ^{241}Pu is discussed. In order to obtain useful results as rapidly as practicable, the high neutron fluxes present in the lattice of a nuclear reactor are usually employed for the irradiations. Under these conditions the large epithermal contents of the neutron spectra made the computation of the 2200 m/sec values, from the measured values, less certain. More

recently, similar measurements have been made in the thermal column of a reactor for ^{239}Pu and ^{241}Pu in an attempt to reduce uncertainty from this source. This technique and its limitations are discussed. (S.F.L.)

4322 USE OF INTEGRAL MEASUREMENTS AS SUPPLEMENTARY DATA IN NEUTRON CROSS-SECTION EVALUATION. Pazy, A.; Rakavy, G.; Reiss, Y.; Yeivin, Y. (Hebrew Univ., Jerusalem). Vienna, International Atomic Energy Agency, 1966, Preprint No. CN-23/15, 16p. (CONF-661014-28). DTIE.

From IAEA Conference on Nuclear Data, Paris.

The exact formulation of a method is given to improve the microscopic cross-section evaluation by means of integral data. Considering a function $\sigma(E)$ and a set of functionals of this function $\gamma_i[\sigma]$, it is proposed that the function $\bar{\sigma}(E)$, which minimizes the quadratic form $\int [(\sigma - \hat{\sigma})/(\Delta\hat{\sigma})]^2 w dE + \Sigma_{i=1}^{N} \{[\gamma_i(\sigma) - \hat{\gamma}_i]/[\Delta\hat{\gamma}_i]\}^2$ is the best estimate of $\sigma(E)$, where $\hat{\sigma}$ is the estimate obtained from the analysis of direct measurements of $\sigma(E)$, $\Delta\hat{\sigma}$ is the standard deviation of a single measurement, and $w(E)dE$ is the significance attributed to the estimate in the interval dE. The $\hat{\gamma}_i$ are the experimental values of $\gamma_i[\sigma]$, and $\Delta\hat{\gamma}_i$ are their standard deviations. Explicit expressions for $\bar{\sigma}(E)$ and $\Delta\bar{\sigma}(E)$ are derived, and various special cases and applications are discussed. To illustrate the method, data from a few simple systems are used to correct the appropriate cross sections. (auth)

4323 DIRECT AND ABSOLUTE MEASUREMENTS OF AVERAGE FISSION NEUTRON YIELD FROM ^{235}U AND ^{252}Cf. De Volpi, A.; Porges, K. G. (Argonne National Lab., Ill.). Vienna, International Atomic Energy Agency, 1966, Preprint No. CN-23/40, 12p. (CONF-661014-18). DTIE.

From IAEA Conference on Nuclear Data, Paris.

A recent survey by the IAEA has shown that significant discrepancies exist among absolute values of $\bar{\nu}$ and σ_f. For $\bar{\nu}(^{235}U)$ only one measurement, made in 1958 with a quoted precision of 1.5%, is considered independent, and the Westcott group [Atomic Energy Rev. 3: 2(1965)] reports that the original value has been lowered so that it is now 2.5% below the recommended least-squares average. There are four accepted values for $\bar{\nu}$ (^{252}Cf), one of which is also about 2.5% lower than the least squares fit; another is 1.6% low, while the average of all measurements is 1% below the recommended values derived from the multiparameter fit. A similar situation exists with regard to 2200 m/s fission cross-sections, wherein the discrepancies far exceed the precision quoted for each experiment. Since these measurements represent the cornerstone of a strongly interrelated structure of nuclear data utilized in reactor physics, it is important that they be independently and accurately evaluated, despite the fact that there exists strong confidence in σ_a, η, and α values which provide an overdetermined set of parameters. An experiment is reported which has been designed to circumvent certain plausible systematic errors which may be responsible for the discrepancies. The total neutron yield was measured for thermal neutron fission of ^{235}U and also independently for ^{252}Cf with an improved manganese bath apparatus. Evaluation of possible error sources has led to the adoption of a sequence of precision techniques subjected to extensive verification. The neutron yield of a fission counter was determined with the manganese bath; the accuracy of the bath system was independently corroborated with 0.7% precision against the U. S. National Bureau of Standards secondary neutron source. Absolute beta-gamma and relative gamma-gamma coincidence techniques are important facets of this calibration. The fission rate of the fission counter was found in a separate prompt fission-neutron coincidence experiment, borrowing well-established methods from beta-gamma coincidence work. In the course of this calibration it was discovered that angular anisotropy in fission neutron emission is much more a problem than universally realized; it is possible that some of the discrepancies in reported $\bar{\nu}$ and σ_f measurements result from discounting this correction too readily. This conclusion is supported with a series of angular traverses and by the contemporary $\bar{\nu}$ results reported. (auth)

Nuclear Theory

Refer also to abstracts 3971, 4197, 4201, 4209, 4214, 4225, 4226, 4236, and 4309.

4324 (JINR-P-2881) O KVAZIUPRUGOM RASSEYANII CHASTITS VYSOKIKH ENERGII NA LEGKIKH YADRAKH. (On the Quasielastic Scattering of High-Energy Particles by Light Nuclei). Bannik, B. P.; Lyuboshits, V. L.; Podgoretskii, M. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1966. 20p. Dep. mn.

The isotopic and ordinary spin-selection rules for quasielastic scattering in high-energy particle collisions with light nuclei are discussed and systematized in the framework of the impulse approximation. The angular dependence of the cross sections for the nuclear level excitation and charge exchange in the region of small momentum transfers is analyzed. The relations are given between the quasielastic scattering cross section and the γ- or β-decay rate. The study of quasielastic scattering on light nuclei can provide valuable information about the spin-spin interaction contribution to the elastic n-n scattering amplitude. (auth)

4325 (ORO-2791-19, pp 75-135) THEORETICAL STUDIES. (Texas Nuclear Corp., Austin).

Theoretical studies of the $(n,n'\gamma)$ reaction mechanism, gamma angular distributions and cross sections, and nuclear level spins and parities were continued. Theoretical calculations of the gamma angular distributions were compared with experimental results in order to study the range of applicability of the Satchler formalism. Theoretical calculations were made for ^{59}Co, ^{55}Mn, ^{93}Nb, ^{23}Na, ^{51}V, and ^{89}Y; spin-parity assignments were made for a number of nuclear levels. A computer code TRNRX was developed for the calculation of gamma angular distributions using the Satchler formalism with spin-orbit coupling. The effect of width fluctuations on gamma distributions in $(n,n'\gamma)$ reactions were studied; preliminary calculations were made for the distribution of the 2.61-MeV gamma ray from the $^{208}Pb(n,n'\gamma)$ reaction at 3.0 MeV. (D.C.W.)

4326 (PUC-937-222) BOUND ISOBARIC ANALOG STATES IN MEDIUM-WEIGHT NUCLEI. Rost, E. (Princeton Univ., N. J. Palmer Physical Lab.). July 1966. Contract AT(30-1)-937. 6p. (CONF-660906-36). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From International Conference on Nuclear Physics, Gatlinburg, Tenn.

The 28-MeV (p,d) data of Sherr [Phys. Rev. 139: B1272(1965)] in which $^1/_2^-$ analog states were observed in medium-weight nuclei were re-examined in the light of recent improvements in the distorted-wave analysis. These improvements bring the extracted spectroscopic strengths in agreement with theory. The use of a constant-well-depth model indicates a larger proton than neutron radius for the observed $f_{\frac{1}{2}}$ orbitals. (auth)

4327 (PUC-937-229) EFFECTIVE FORCES IN NUCLEI. Brown, G. E. (Princeton Univ., N. J. Palmer Physical Lab.). Sept. 1966. Contract AT(30-1)-937. 16p. (CONF-660906-35). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From International Conference on Nuclear Physics, Gatlinburg, Tenn.

A review is presented on the calculation of effective forces in nuclei from the nucleon-nucleon force. Good results were obtained by calculating the effective matrix elements starting from the Brueckner-Bethe reaction-matrix techniques. It is suggested that the techniques be extended to incorporate realistic forces in the Hartree-Fock calculations and in nuclear reaction studies. (S.F.L.)

4328 (UCD-CNL-68) SOLUBLE THREE-BODY MODEL OF STRIPPING. Dodd, L. R. (California Univ., Davis. Crocker Nuclear Lab.). Aug. 23, 1966. Contract AT-11-1-GEN-10. 7p. (CONF-660906-39). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From International Conference on Nuclear Physics, Gatlinburg, Tenn.

A soluble, three-body model of deuteron stripping, which is based on a new reduction of the Faddeev equations, is described. An important advantage of the model is that the separable potential approximation is used only for the proton-neutron system; the proton-core, neutron-core interactions may be central. The three-body dynamics are treated exactly. (auth)

4329 (UCRL-17070) ANOMALIES IN NUCLEAR MASSES. Myers, William D.; Swiatecki, Wladyslaw J. (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 10, 1966. Contract W-7405-eng-48. 24p. (CONF-660817-7). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From International Symposium on Why and How Should We Investigate Nuclides Far Off the Stability Line, Lysekil, Sweden.

Recently gained insight into the nature of the shell correction to the mass of a nucleus, regarded as a function of nuclear deformation, enables one to understand some of the outstanding anomalous trends in nuclear masses, including the behavior of fission barriers. (auth)

4330 EFFECT OF FINITE DIMENSIONS OF NUCLEI AND THE SCREENING FACTOR IN THE THEORY OF E0 CONVERSION AND STRUCTURAL INTERNAL CONVERSION COEFFICIENTS. Borisoglebskii, L. A.; Davydova, G. V. (Belorussian State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 1, 54-9 (1966). (In Russian).

In view of the fact that earlier corrections to the theoretical relative and absolute probabilities of EO conversion were limited

to the effects of finite nuclear dimensions and to screening, and were confined essentially to corrections to absolute but not to relative probabilities, the effects of the finite dimensions of the nucleus, the allowance for terms of the order of αZR and pR (α = fine-structure constant, Z and R the charge and radius of the nucleus, and p is the conversion-electron momentum in the final state of the continuous spectrum), which are neglected in the analytic relations, were investigated. The corrections for the nuclear size and for the αZR and pR terms were found to be negligible. The greatest correction to the relative probability was found to be due to screening. In the case when Z is sufficiently large, it was found that the net result of all the corrections was small, and particularly since some can cancel others. Corrections to the relative "purely structural" internal conversion coefficients, calculated in the approximation of the pointlike nucleus, were also investigated. These were found to reach as much as 10% in some cases. The screening calculations were made difficult by the fact that in the case of the higher shells there are still no exact values of the quantities required for the calculations. (ATD)

4331 ATOMIC NUCLEI: MOMENTS OF INERTIA AND QUADRUPOLE MOMENTS. Strnad, J. (Univ. of Ljubljana, Yugoslavia. Josef Stefan Inst., Ljubljana, Yugoslavia). Science, 154: 259-61(Oct. 14, 1966).

Moments of inertia and quadrupole moments of deformed even–even nuclei were calculated in the closely packed spheron model. (auth)

4332 THEORY OF ISOBARIC STATES AND HINDERED FERMI NUCLEAR MATRIX ELEMENTS. Fujita, Jun-ichi; Ikeda, Kiyomi (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 36: 530-50(Sept. 1966).

The hindered Fermi matrix elements for beta decays are investigated theoretically. For that purpose previously proposed techniques are used, including the series expansion of the isospin projection operators, and the effective transition operator for hindered processes. The physical meaning of the effective beta coupling constant for heavy nuclei is clarified. Also, a theory of the isobaric states, which were experimentally discovered in the (p,n) reactions, is presented in terms of the projection operator formalism. It is shown that the observed magnitudes of the hindered Fermi matrix elements and the widths of the isobaric states are mutually consistent. Since the Fermi transition is the most fundamental of all the beta processes, it is hoped that the arguments give a clue to the complicated beta systematics. It is also asserted that a serious breakdown of charge-symmetry for nuclear forces is highly unlikely. (auth)

4333 RENORMALIZATION EFFECT DUE TO THE GROUND STATE CORRELATION ON THE NUCLEAR VIBRATIONAL MOTION. Bando, Hiroharu (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 36: 551-67(Sept. 1966).

A method is given which takes into account the renormalization effects due to the ground state correlation in the nuclear vibrational motion of medium and heavy nuclei. The collective eigenmode is taken as a two-quasi-particle mode; this means that Bogoliubov bound pairs break up in a coherent manner. Self-consistent equations are derived which determine the vibrational eigenmodes and the Bogoliubov quasi-particles, both renormalized owing to the effects of the ground state correlations. Calculations are made for the simple case of a single j-shell with the aim of seeing the physical features of the effect, especially the dependence of the effects on the properties of the nuclear interaction, by changing the ratio of the magnitude of the particle-particle and particle-hole matrix elements of the interaction. According to whether the particle-particle or the particle-hole matrix elements of the nuclear interaction is dominant, different results are obtained for the renormalization effects on the quasi-particle energy and the E2 transition probability from the vibrational state to the ground state. In either case the renormalization effects reduce the ground state correlation by reducing the difference of the magnitude of the particle-particle and particle-hole matrix elements. (auth)

4334 FORMAL TREATMENT OF n-p INTERACTIONS IN HEAVY NUCLEI. I. Prosperi, D. (Centro di Studi Nucleari, Casaccia, Italy. Univ., Rome). Nuovo Cimento (10), 44B: 199-203(July 11, 1966).

A formalism for the treatment of n-p interactions is outlined. The formalism does not require the introduction of isotopic-spin co-ordinates. (D.C.W.)

4335 FORMAL TREATMENT OF n-p INTERACTIONS IN HEAVY NUCLEI. II. Prosperi, D. (Centro di Studi Nucleari, Casaccia, Italy. Univ., Rome). Nuovo Cimento (10), 44B: 204-9(July 11, 1966).

A many-body theory based on "two-operator coefficients" is outlined. The theory can be used to describe odd-odd nuclei. (D.C.W.)

4336 EFFECTIVE INTERACTIONS FOR HARTREE–FOCK CALCULATIONS. Brink, D. M.; Boeker, E. (Oxford Univ.). Nucl. Phys., A6702: 1-26(1967).

An attempt was made to find a phenomenological two-body nucleon-nucleon interaction which would reproduce the binding energies and densities of nuclear matter and of various light nuclei in the Hartree-Fock approximation. A sum of two Gaussian potentials, a sum of a Gaussian and a δ function, a velocity-dependent interaction which acts in s-states only, and a velocity-dependent interaction which acts both in s- and p-states were investigated in detail. The parameters of each potential were adjusted to give the experimental binding energies of ^{4}He and nuclear matter at about the experimental densities. With the resulting forces, the binding energies and densities of the ^{16}O and ^{40}Ca ground states and the same quantities for the deformed ^{8}Be and ^{12}C ground states were calculated. Moreover, the single-particle energies and the possibly deformed dipole state, 2p2h and 4p4h states of the ^{16}O nucleus were studied. It appeared that no force could reproduce all experimental data at the same time. (auth)

4337 PHOTON SCATTERING BY VIBRATIONAL NUCLEI IN THE GIANT RESONANCE REGION. Arenhoevel, H.; Weber, H. J. (Univ., Frankfurt am Main). Nucl. Phys., A6702: 145-56(1967).

The dynamic collective theory for spherical nuclei is applied to elastic and inelastic photon scattering. The nuclear matrix elements occurring in the relevant Raman scattering cross sections are derived and computed by methods of group theory. It turns out that the coupling of the giant dipole oscillations with the surface quadrupole modes yields relatively large tensor polarizability for the first 2^+ state of spherical nuclei and, consequently, strong inelastic scattering to the first 2^+ state. This effect should appear experimentally. (auth)

4338 OPTICAL-MODEL CALCULATIONS OF ELASTIC SCATTERING IN LIGHT NUCLEI. Rahman, M. (Atomic Energy Centre, Dacca, Pakistan); Khan, A. H.; Sen Gupta, H. M. Nuovo Cimento (10), 44B: 36-41(July 11, 1966).

Diffuse-surface optical-model analyses were carried out to fit experimental elastic angular distributions in p-^{4}He, d-^{4}He, and ^{3}He-^{4}He systems, and best-fit parameters were obtained. (auth)

4339 CONTRIBUTION OF THE SPIN–EXCHANGE EFFECTS TO THE NUCLEAR MAGNETIC MOMENTS. Demichelis, F.; Iachello, F. (Istituto di Fisica Sperimentale del Politecnico, Turin). Nuovo Cimento (10), 44B: 182-92(July 11, 1966).

The various contributions to the deviations from the Schmidt values of the experimental nuclear magnetic moments are examined. The exchange effects are taken into particular consideration; and, having selected a particular form for these contributions, an explicit expression of this form is given. The magnitude of the unknown function which appears in this expression is fitted to the experimental data. The required value is found to be about the same for many different nuclei. (auth)

4340 NUCLEAR POLARIZATION BY MEANS OF POLARIZED NEUTRONS. Rauch, H. (Oesterreichische Hochschule, Vienna). Z. Phys., 197: 373-88(1966). (In German).

An experimental setup to be used for nuclear polarization by means of the absorption of polarized thermal neutrons is described. The setup consists essentially of a double spectrometer arrangement for polarized neutrons in connection with an arrangement for the detection of the nuclear polarization by means of the anisotropic β decay. The method described is especially useful for short-lived isotopes which can not be polarized by other methods. (auth)

4341 PROBLEM OF PENETRATION EFFECTS IN INTERNAL CONVERSION. Voikhanskii, M. E.; Listengarten, M. A.; Feresin, A. P. (Leningrad State Univ.). Yadern. Fiz., 4: 66-71(July 1966). (In Russian).

Anomalies in internal-conversion coefficients are connected with the difference in the selection rules for γ transitions and conversion transitions, due to the penetration of an electron into the nucleus. In cases when the first terms in the expansion of the penetration conversion matrix elements are negligible, higher terms play a significant role, and selection rules with respect to asymptotic quantum numbers are obtained for them. (auth)

4342 THEORY OF NON-NORMAL PARITY STATES OF DOUBLY-CLOSED SHELL PLUS ONE-NUCLEON SYSTEMS. Goswami, Amit; Sherwood, Arnold I. (Univ. of California, San Diego, La Jolla). Nucl. Phys., A6702: 64-74(1967).

A method is developed for the calculation of non-normal parity

vibration and single-particle strength functions for nuclei with one nucleon outside a doubly-closed shell. The coupled linearized equations for the amplitudes of excitation of the states of the odd-mass nucleus are obtained by considering the equation of motion of the odd nucleon. This is accomplished by employing an expansion in terms of a complete set of states of the closed-shell core, yielding a hermitian matrix. The states of the core are treated by the hole-particle-RPA method. Numerical calculations are presented for ^{17}O. It is found that no single phonon-coupled or single-particle state occurs below 5 MeV. (auth)

4343 EVIDENCE FOR A COMPLEX SYMMETRY TERM IN THE OPTICAL POTENTIAL FOR NUCLEONS. Satchler, G. R. (Oak Ridge National Lab., Tenn.). Nucl. Phys., A6702: 75-84(1967). (ORNL-P-2451).

The scattering of 24-MeV neutrons is studied using an optical-model potential previously obtained from analysis of 30-MeV proton scattering. The nonelastic and total cross sections and to a lesser extent the differential cross sections indicate that the strength W_D of the surface absorption potential has a term proportional to the relative neutron excess $(N - Z)/A$ with opposite signs for neutrons and protons. This may be interpreted as arising from a complex potential term proportional to $t \cdot T$. This result may be related to other indications that the neutron distribution in neutron-rich nuclei has a larger radius than the proton distribution. (auth)

4344 QUALITATIVE DESCRIPTION OF NUCLEAR COLLECTIVITY. Bertsch, G. F.; Broglia, R. A.; Riedel, C. (Univ. of Copenhagen). Nucl. Phys., A6702: 123-32(1967).

The characteristic feature of many types of collective states in the shell model is a spatial correlation between particles and holes. Several examples are discussed, which clarify the relation between different types of collectivity. (auth)

4345 PAIRING-PLUS-QUADRUPOLE MODEL CALCULATIONS FOR TUNGSTEN, OSMIUM, AND PLATINUM NUCLEI. Kumar, K. (Michigan State Univ., East Lansing); Baranger, M. Phys. Rev. Lett., 17: 1146-8(Nov. 28, 1966).

Seven arbitrary functions of β and γ in Bohr's collective Hamiltonian were calculated by applying time-dependent Hartree–Bogolyubov techniques to a microscopic model of the nucleus, the pairing-plus-quadrupole model. The energy levels, transition probabilities, and static moments were computed by using a completely numerical method. The results are compared with experimental values. (M.H.R.)

4346 ELASTIC SCATTERING OF 52-MeV DEUTERONS. Duelli, B.; Hinterberger, F.; Mairle, G.; Schmidt-Rohr, U.; Turek, P.; Wagner, G. (Kerforschungszentrum, Karlsruhe, Ger. Kernforschungsanlage, Juelich, Ger. Max-Planck-Institut fuer Kernphysik, Heidelberg). Phys. Lett., 23: 485-7 (Nov. 21, 1966).

The angular distributions for the elastic scattering of 52-MeV deuterons from 16 nuclei ranging from carbon to uranium were measured. The optical model is found to describe the experimental results if one accounts for the spin-orbit interaction. (auth)

4347 WEAK COUPLING MODEL OF A CORE PLUS SEVERAL PARTICLES. Rinard, Phillip M.; McKinley, John J. (Kansas State Univ., Manhattan). Nucl. Phys., 6701A: 523-8 (1967).

A nuclear model consisting of a core plus several particles is considered with interactions between each particle and the core and among the particles. It is shown that the energy levels of a several-particle nucleus can be expressed in terms of the levels of the one- and two-particle nuclei. An application is then made to ^{193}Au and ^{195}Au in which it is seen that the core-particle interaction alone is sufficient to account for the features of the observed levels. (auth)

4348 TREATMENT OF THE CONTINUUM–CONTINUUM INTERACTION IN THE SHELL-MODEL APPROACH TO NUCLEAR REACTIONS. Gloeckle, W.; Huefner, J.; Weidenmueller, H. A. (Univ., Heidelberg). Nucl. Phys., 6701A: 481-507(1967).

In the shell-model approach to nuclear reactions, the treatment of the continuum–continuum interaction due to the residual nucleon–nucleon potential causes a serious numerical problem. A method, based upon work by Weinberg is proposed to modify the continuum–continuum interaction operator in such a way that it may be treated in perturbation theory. This is achieved by subtracting from this operator an operator of finite rank. A prescription for the construction of the latter is given, and an approximation scheme to this prescription is introduced. Numerical examples show that the method converges rapidly. The relation of the method to the Fano treatment and several other approaches is discussed. The S-matrix is decomposed into two parts, the first of which is the compound-nuclear contribution and the second of which resembles the familiar DWBA amplitude. (auth)

4349 INFLUENCE OF THE CHARGE EXCHANGE PROCESS ON THE (d,p) STRIPPING CROSS SECTIONS. Zaidi, S. A. A.; Von Brentano, P. (Univ. of Texas, Austin). Phys. Lett., 23: 466-7(Nov. 21, 1966).

The effect of the charge exchange (p,n) scattering in the proton channel is explicitly included in a DWBA expression for the (d,p) stripping reaction. The expression obtained predicts anomalies in the energy dependence of the cross section. (auth)

4350 THE WKB CALCULATION OF THE NUCLEAR ISOTOPE SHIFT. Krainov, V. P. (Kurchatov Atomic Energy Inst., Moscow); Mikulinsky, M. A. Phys. Lett., 23: 465(Nov. 21, 1966).

A semi-classical formula for calculations of the change of the mean-square nuclear radii caused by the addition of a neutron is suggested. (auth)

4351 DEUTERON DECAY IN THE FIELD OF THE NUCLEUS. Popova, A. M. (Univ. of Copenhagen); Komarov, V. V. Nucl. Phys., 6701A: 625-34(1967).

The amplitude of the $A + d \rightarrow n + p + A$ reaction was obtained on the basis of the diagram-summation method for the particular configurations of the particle in the final state, when the neutron and proton have a small relative energy or when one of the nucleons and the nucleons and the nucleus have a small relative energy. It was shown that from the analysis of the experimental data of the reaction $A + d \rightarrow n + p + A$ and by using the formula obtained, the value of the spin-dependent and spin-independent parts of the nucleon-nucleus scattering amplitude can be found. (auth)

4352 SCATTERING AMPLITUDE OF FOUR NON-RELATIVISTIC PARTICLES. Popova, A. M. (Univ. of Copenhagen); Komarov, V. V. Nucl. Phys., 6701A: 635-49(1967).

The exact integral equations for the nonrelativistic four-particle scattering amplitudes are obtained, assuming only two-body forces. These equations can be solved when in the final state there are two pairs of particles with small relative energy of particles in the cms of each pair. As an example, the reaction $d + d \rightarrow n + p + d$ is considered. (auth)

4353 THEORY OF α MATTER. Clark, John W.; Wang, Tso-pin (Washington Univ., St. Louis). Ann. Phys. (N. Y.), 40: 127-52(Oct. 17, 1966).

The usual concept of nuclear matter is discussed, and a generalization of this concept which allows a qualitative understanding of the effects of clustering phenomena is proposed. As an example of "generalized nuclear matter," the properties of the ground state of a uniform extended system of structureless α particles are studied using the method developed by Wu and Feenberg for liquid ^4He. The Wu-Feenberg method requires the use of (1) a Bijl-Dingle-Jastrow wave function and (2) the Kirkwood superposition approximation. The assumed α-α interactions fit the S-wave phase shifts up to a c.m. energy of 10 MeV. The results, in comparison with results from theoretical nuclear-matter calculations which entertain no clustering (both expressed in terms of the energy per nucleon as a function of the radius of the (average) volume per nucleon) are of value in making crude estimates of the percentage of the surface matter of a heavy nucleus which prefers to form into α clusters and in interpreting empirical values for the compressibility of nuclear matter. (auth)

4354 SIMPLE SURFACE INTERACTION MECHANISM FOR MAGNETIC SUBSTATE EXCITATION BY INELASTIC SCATTERING. Verhaar, B. J.; Tolsma, L. D. (Technische Hogeschool, Eindhoven, Netherlands). Nucl. Phys., 6701A: 612-24(1967).

A simple model is presented to explain the marked behavior of the de-excitation γ pattern in certain recent inelastic α-particle scattering experiments from even nuclei ($0^+ \rightarrow 2^+$ excitation). The model is a slight generalization of the well-known ring-locus model in that it is based on a ring locus of finite angular width. The dependence of the inelastic angular distribution and the reaction-plane γ pattern on the parameters of the ring locus is discussed. (auth)

4355 PARTICLE-HOLE EXCITATIONS WITH A COMPLETE SINGLE-PARTICLE BASIS. I. THE POINT SPECTRUM. Agodi, A.; Catara, F.; Di Toro, M. (Univ., Catania, Italy). Ann. Phys. (N. Y.), 40: 1-18(Oct. 17, 1966).

The truncated set of single-particle wave functions commonly used in nuclear-spectroscopic Tamm-Dancoff (TD) calculations was completed to allow the construction of a complete set of particle-hole states. In the space spanned by such states, the method of the equivalent problem in a subspace was applied to get the discrete spectrum of 0^-, 1^-, and 3^- particle-hole excitations in ^{12}C and ^{16}O, by using explicitly given projection operators and a suitably simplified extension of the standard TD hamiltonian with zero-range two-body interactions. The extended TD approximation gives, as expected on general grounds, eigenvalues lower than the corresponding values obtained in the usual TD ap-

proximation: but the shift never exceeds 1 MeV in the cases considered. The main effect of the extension has therefore to be read in the wave-function-dependent properties of the states. (auth)

4356 CALCULATION OF THE RATIO OF ISOMERIC CROSS SECTIONS. Sperber, D. (Illinois Inst. of Tech., Chicago). Nucl. Phys., 6701A: 665-72(1967). (IITRI-578-P25-18).

A more rigorous method for calculating the ratio of isomeric cross sections was developed. The method is particularly valuable when the energy and spin distributions are known before the gamma rays populating the isomeric and ground states start to cascade. The usefulness of the method was demonstrated by applying it to the analysis of the ratio of isomeric cross sections in the $^{196}Hg(n,\gamma)^{197}Hg$ reaction, which was initiated by thermal neutrons. (auth)

4357 ANALYTICAL EXPRESSIONS FOR INELASTIC SCATTERING CROSS SECTIONS. PART II. Varma, S.; Dar, A. (Weizmann Inst. of Science, Rehovoth, Israel). Ann. Phys. (N. Y.), 39: 435-52(Oct. 4, 1966).

Closed-form expressions are derived for the differential cross section for inelastic scattering via mutual and double collective excitations and under strong absorption conditions. The expressions result in the generalized Blair phase Rules. The predictions are compared with experimental data; good agreement is obtained. (auth)

4358 SHELL MODEL STUDIES OF 1f,2p-SHELL NUCLEI. II. ORBITAL $\langle f^2 f^2/f^4\rangle$ FRACTIONAL PARENTAGE COEFFICIENTS FOR THE NUCLEAR f^4 CONFIGURATION. Nagai, Hiroyuki (Kyushu Inst. of Tech., Tobata, Japan); Itaya, Mitsuo. Bull. Kyushu Inst. Technol., Math., Natur. Sci., No. 11, 19-23(1964).

The totally antisymmetric states for the f-shell nuclei previously given [H. Nagai and M. Itaya, Bull. Kyushu Inst. Techn., M. and N. S., No. 10, 41(1963)] are transformed into the form of linear combinations of antisymmetric states for two particles vector-coupled to antisymmetric states of particles 3 and 4. The coefficients of the combinations, the $\langle f^2 f^2/\xi f^4\rangle$ fractional parentage coefficients, are products of weight factors, orbital factors, and charge-spin factors. Of these, the orbital factors are calculated from the $\langle f^3 f/\xi f^4\rangle$ and $\langle f^2 f/\xi f^3\rangle$ coefficients obtained previously. The results are listed in tables. (auth)

4359 COULOMB ENERGY SYSTEMATICS. Jaenecke, Joachim. (Univ. of Michigan, Ann Arbor). Z. Phys., 196: 477-85 (1966).

A new type of plot for the Coulomb energy differences between isobaric analog states of neighboring isobaric nuclei with $T_z = T - 1$ and $T_z = T$ is introduced. The available experimental data when displayed in this form reveal nuclear structure effects. (auth)

4360 EXTENDED NOMOGRAM FOR LOG FT VALUES. Verrall, R. I.; Hardy, J. C.; Bell, R. E. (McGill Univ., Montreal). Nucl. Instrum. Methods, 42: 258-60(July 1966).

A nomogram relating log-ft values to the maximum beta decay energy and the partial half life of the decay was constructed including decay energies greater than 9 MeV. The graph of the Coulomb correction factor was also extended. An approximate correction was made to take into account the effect of screening by the atomic electrons. (D.C.W.)

4361 TARGET ANGLE OPTIMIZATION FOR MINIMUM ENERGY SPREAD. Need, J. L. (Lewis Research Center, Cleveland). Nucl. Instrum. Methods, 42: 283-5(July 1966).

The conditions are examined under which the energy spread in outgoing particles from a nuclear reaction due to finite target thickness is minimized. Physical restrictions on the angle of incidence and emission are explicitly considered, and it is shown that the minimum in energy spread does not always occur at the limits. Targets are considered both in transmission and in reflection. (auth)

4362 OBSERVATION OF COMPLEX SINGULARITIES OF DIRECT NUCLEAR REACTION AMPLITUDES. Dubovoi, E. I. (Inst. of Theoretical and Experimental Physics, Moscow); Shapiro, I. S. Zh. Eksp. Teoret. Fiz., 51: 1251-9(Oct. 1966). (In Russian).

The cross sections for direct reactions of the type A(x,xy)B are considered as a function of the transferred momentum and kinetic energy of the emitted particles near a moving complex singularity with respect to these variables. It is mentioned that normal threshold singularities of triangular diagrams may be used to identify the mechanism of the reaction. Analytical formulas are obtained for the differential cross section, and patterns of the horizontal surface corresponding to the cross section are presented. (auth)

4363 VIRTUAL SCATTERING EFFECTS IN DIRECT NUCLEAR REACTIONS. Kaminskii, V. A.; Orlov, Yu. V.; Shapiro, I. S. (Inst. of Physics and Tech., Moscow). Zh. Eksp. Teoret. Fiz., 51: 1236-50(Oct. 1966). (In Russian).

A detailed derivation is presented of formulas expressing the cross sections for direct processes in which interactions in the initial and final states are taken into account via the elastic-scattering phase shifts in the physical region. The derivation is based on dispersion theory. A method for taking into account simultaneously nuclear and Coulomb interactions of charged particles is considered within the framework of the method. The analytic structure of the reaction amplitude is investigated for a potential model for which the dispersion relations may be written down. The contribution of nonphysical singularities of the nuclear scattering amplitude is considered. With the direct reaction $^{13}C(\gamma,n)^{12}C$ as an example, it is shown that the nonphysical singularity contribution may be neglected. (auth)

4364 THE CONTRIBUTION OF THE ONE-PION EXCHANGE POTENTIAL IN THE FRAME OF A HARTREE-METHOD BY USING ONE-PARTICLE WAVE FUNCTIONS WITHOUT DEFINITE PARITY. Roehl, W. H. (Univ., Colgne). Z. Phys., 195: 389-405 (1966).

In order to calculate the spin-orbit splitting and the magnetic moments of nuclei a Hartree method was used together with parity-mixed one-particle wave functions. Along with the phenomenologically determined scalar potential, a pseudoscalar potential derived as the contribution of the self-consistently determined one-pion exchange potential was used. By using this method of parity-mixing, one obtains a spin-orbit splitting and also magnetic moments, which lie automatically between the Schmidt-lines in good agreement with the experimental values. Only the π-N coupling constant was used as a parameter in this self-consistent method. It is shown that a smaller coupling constant is obtained when using the exact solution of this problem than by using perturbation theory. This effective coupling constant is of the same order of magnitude as the one obtained from the scattering data. (auth)

4365 OPTICAL-MODEL FITTING PROCEDURE FOR FAST NEUTRON CROSS SECTIONS. Chien, J. P. (National Tsing Hua Univ., Taiwan, China). Chin. J. Phys. (Taiwan), 4: 16-26(Apr. 1966).

The effects of each potential parameter on neutron differential scattering cross sections are demonstrated. Some ambiguities and the fitting procedure for the optical model are discussed. (auth)

4366 EXACT CALCULATIONS IN THE d-s NUCLEAR SHELL. Broglia, Ricardo A.; Maqueda, Ernesto E. (Facultad de Ciencias Exactas y Naturales, Buenos Aires). Nucl. Phys., 86: 457-70(1966).

The pairing plus quadrupole interactions and the Wigner-Gaussian force were diagonalized for four like particles moving in the N = 2 shell of the harmonic oscillator, and its solutions were compared. The states of the basic representation are classified according to the SU_3 coupling scheme. The results are discussed in terms of the vibrational and rotational models. (auth)

4367 VALIDITY OF MANY-BODY APPROXIMATION METHODS FOR A SOLVABLE MODEL. IV. THE DEFORMED HARTREE-FOCK SOLUTION. Agassi, D. (Weizmann Inst. of Science, Rehovoth, Israel); Lipkin, H. J.; Meshkov, N. Nucl. Phys., 86: 321-31(1966).

The previous treatment of a model with particles in two degenerate levels interacting via a monopole force is extended to the case of strong interaction. A deformed Hartree–Fock solution is shown to exist when the interaction strength exceeds the critical value where the collective monopole vibration becomes unstable in the random phase approximation. Properties of the deformed solution are compared with the exact solution with particular emphasis on the physical interpretation as a simplified model of the Bleuler, mixed-parity, Hartree–Fock treatment of the nuclear shell model. (auth)

4368 STUDY OF THE DISPERSION PHENOMENA ASSOCIATED WITH THE MOESSBAUER ABSORPTION LINES OF ^{57}Fe. Imbert, P. (Centre d'Etudes Nucleaires, Saclay, France). J. Phys. (Paris), 27: 429-32(July-Aug. 1966). (In French).

Dispersion phenomena near the Moessbauer absorption lines were investigated by means of experiments using birefringence and Faraday rotation which permit polarimetry to be used in the field of low-energy gamma rays. (auth)

4369 METHOD TO TREAT CONFIGURATION MIXING ACROSS MAJOR SHELLS. Gupta, K. K.; Khadkikar, S. B.; Parikh, J. C. (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys., 86: 449-56(1966).

The SU_3 scheme of Elliott is extended to take account of mixing of configurations across major harmonic oscillator shells. A specific interaction is chosen for this mixing, which can be solved

exactly within an SU_4 scheme. As illustrations the spectra of ^{8}Be and ^{16}O are calculated. (auth)

4370 AN OPTICAL MODEL STUDY OF NEUTRONS ELASTICALLY SCATTERED BY IRON, NICKEL, COBALT, AND COPPER IN THE ENERGY REGION 1.5 TO 4.6 MeV. Holmqvist, B.; Wiedling, T. (Aktiebolaget Atomenergi, Studsvik, Sweden). Vienna, International Atomic Energy Agency, 1966, Preprint No. CN-23/85, 16p. (CONF-661014-22). DTIE.

From IAEA Conference on Nuclear Data, Paris.

Angular distributions of neutrons elastically scattered by cobalt and natural copper were measured at seven energies between 1.5 and 4.6 MeV using the time-of-flight technique. The observed angular distributions were corrected for neutron-flux attenuation, multiple elastic scattering, and the finite geometry of the source-sample-detector system by using a Monte Carlo program. Theoretical angular distributions were fitted to the experimental angular distributions by using an optical-model potential of the form $-V(r) = Uf(r) + iWg(r) + U_{SO}(\hbar/\mu_\pi c)^2 (1/r)(d/dr)|f(r)|\vec{\sigma}\times\vec{l}$ where U, W, and U_{SO} are the real, imaginary, and spin-orbit potential depths, respectively. The form factors f(r) and g(r) are given by the expressions $f(r) = \{1 + \exp[(r-R_U)/a]\}^{-1}$ and $g(r) = 4\{1 + \exp[(r-R_W)/b]\}^{-2} \exp[(r-R_W)/b]$, where a and b are the diffuseness parameters and $R_U = r_{oU} A^{\frac{1}{3}}$ and $R_W = r_{oW} A^{\frac{1}{3}}$ are the radii. The automatic search routine of the Abacus II computer program was used to find the values of U, W, a, r_{oU}, and r_{oW} which give the best fittings to the experimental distributions when U_{SO} and b were kept constant. The values of U_{SO} = 8 MeV and b = 0.48 fm were used throughout the calculations. The compound elastic contribution was taken into account in each case. The parameters U, W, a, r_{oU}, and r_{oW} are essentially independent functions of the neutron energy. The values obtained for r_{oU} and r_{oW} indicate that r_{oU} is somewhat larger than r_{oW}. Very good agreement between experiment and theory was obtained by using this spherical potential. (auth)

4371 ELASTIC AND INELASTIC NEUTRON CROSS SECTIONS. Wilmore, D. (Atomic Energy Research Establishment, Harwell, Eng.). Vienna, International Atomic Energy Agency, 1966, Preprint No. CN-23/37. 16p. (CONF-661014-33). DTIE.

From IAEA Conference on Nuclear Data, Paris.

Computer programs were developed for the calculation of elastic and inelastic scattering of particles from nuclei. These programs are written in the S2 dialect of Fortran and are run on an IBM 7030 computer. One program calculates the shape-elastic cross section, the total cross section, and the absorption cross-section according to the optical model. The time taken in performing an optical calculation depends mainly upon the efficiency of the method used to perform the integration of the radial Schrodinger equation. A method is used which takes advantage of the absence of the first derivative term, and this gives a great improvement over more general methods. A least squares fitting procedure is used which enables any number of parameters to be varied. The number of optical-model calculations which are needed for a least squares fit is less than with usual methods. Another program calculates compound-nucleus reactions according to the Hauser-Feschbach theory, with or without the fluctuation correction. This program will accept target and projectiles of any spin and parity, so that deuteron and alpha channels, as well as nucleon channels, may be taken into account. A third program enables least-squares fits of elastic scattering to be done by taking into account the compound elastic contribution as calculated by the Hauser-Feshbach theory. The use of these programs is illustrated by the analysis of the inelastic scattering of neutrons from ^{238}U. The elastic scattering cross sections were used to obtain optical potentials by a least squares fitting method. These potentials were subsequently used to predict the inelastic cross sections to a large number of excited states. The results using the fluctuation correction are in good agreement with experiment. A further example of their use is shown in the analysis of neutron and proton scattering from light nuclei. Proton cross sections were analyzed to obtain potentials which were then used to calculate neutron cross sections. The results are in reasonable agreement with experiment when it is considered that this is a region of the periodic table where the optical model is not particularly good. (auth)

4372 SYSTEMATIC ERRORS OF THE EFFICIENCY TRACER TECHNIQUE FOR THE MEASUREMENT OF THE ABSOLUTE DISINTEGRATION RATES OF PURE β EMITTERS. Williams, A.; Goodier, I. W. (National Physical Lab., Teddington, Eng.). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-79/30, 16p. (CONF-661012-29). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

A basic requirement of the theory of the efficiency tracer technique is the generally accepted assumption that there is a linear relation between the efficiencies of the pure β-emitter and the tracer. However, an estimate of the inherent accuracy of the efficiency tracer technique has shown that, on theoretical grounds, this linear relation would only be expected if the end point energies and the shape of the β-spectra of the tracer and pure β-emitter were identical, the departure from linearity depending upon the ratio of the respective end point energies. An experimentally determined value of the absolute disintegration rate of the pure β-emitter, obtained using a linear relation, would have a significant systematic error if this relation was in fact non-linear, for the usual straight-line extrapolation to 100% efficiency for the tracer would have to be replaced by an extrapolation with a significant curvature. In order to look for any non-linearity in the relation it is first necessary to reduce the random measurement errors to a minimum. A derivation is given of an expression for the expected value of these random errors in terms of the known statistical errors in the measurement. This expression shows that the ratio of the pure β-emitter and tracer activities can be chosen to make the random errors a minimum. It is shown that it is possible to obtain an experimental error, which is comparable to that predicted in the expression derived above, for a pure β-emitter and tracer, combined in the same chemical form, whose end point energies are similar (e.g., ^{32}P and ^{24}Na). To look for any non-linearity in the relation between pure β-emitter and tracer efficiencies, ^{35}S (end point energy E_0 = 168 keV) was measured using ^{60}Co (E_0 = 310 keV) and ^{134}Cs (effective E_0 = 110 keV) as tracers. The results of these measurements showed that there was a significant curvature, of opposite sign, for the two tracers used. A least squares, second-degree polynomial fit to the data gave agreement within the errors for the ^{35}S activity, whereas the values obtained from a straight line fit differed by 8%, the value obtained using ^{60}Co being 2% below and that from ^{134}Cs 6% above the value given by the polynomial fit. (auth)

4373 APPLICATIONS OF GENERALIZED R-MATRIX THEORY TO SIMPLE SCATTERING MODELS. Purcell, James Eugene (Case Inst. of Tech., Cleveland). 116p. (CONF-660411-60). ORAU. Gmelin, AED-CONF-66-060-139.

From American Physical Society Meeting, Washington, D. C.

The generalized R-matrix formalism for nuclear reactions of Tobocman and Nagarajan was studied by applying it to simple potential-scattering problems. Particular attention was devoted to zero potential, square-well potential, and to a pair of coupled square wells. In each case, approximate basis states are found by matrix diagonalization and the scattering wave functions are expressed in terms of this basis in accordance with the theory. Numerical comparisons between the exact and approximate results indicate that generally the approximation converges fairly rapidly and gives a good representation of the exact cross section. However, the approximate results deviate seriously from the exact cross section near certain energy values causing non-physical resonances to appear. Such false resonances can be easily identified and, in fact, will not appear in most practical applications. (auth)

REACTOR TECHNOLOGY

Central Power Reactors

Refer also to abstracts 4397 and 4398.

4374 (AE-246) OPERATING EXPERIENCE AT THE AGESTA NUCLEAR POWER STATION. Sandstroem, S. (ed.) (Aktiebolaget Atomenergi, Stockholm (Sweden)). Sept. 1966. 115p. Dep. mn.

The operating experience of Agesta since its start to the end of 1965 is reported. After a description of the plant circuits, the Agesta Log, which covers the period up to the summer break of 1966, is given. The experiences are discussed under the following headings: heavy water components, special operational procedures, instrumentation and control, fuel and control rod handling, chemistry, radiation hazards, electrical installations, and reactor physics experiments. (D.L.C.)

4375 (GA-6689) GASP-II: A COMPUTER CODE FOR BURNUP-INDEPENDENT POWER SHAPING BY FUEL ZONING INCORPORATING A POISON SEARCH. Simon, W. A.; Van Howe, K. R. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Oct. 11, 1965. Contract AT(04-3)-167. 142p. Dep. mn. CFSTI $4.00 cy, $1.00 mn.

A derivation of the criteria required to achieve a stable power distribution in a reactor core with any desired shape is given in this report. The computer code, GASP-II, using these criteria to achieve any desired burnup-invariant power distribution, is described. (J.C.W.)

4376 (GAMD-6651) POWER DISTRIBUTION IN 330 Mw HTGR INITIAL CORE. Malakhof, V.; Simon, W. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Apr. 27, 1966. Contract AT(04-3)-633. 25p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

The power distribution of the 330 HW(e) High-temperature Gas-cooled Reactor (HTGR) core was studied. The computations were performed for the initial core at a uniform fuel temperature of 1300°K and a uniform moderator temperature of 1200°K. The perturbation of the power distribution due to control-rod insertion, or arbitrary variation of Th feed concentration in certain refueling zones, was investigated. Radial and axial power shapes are in reasonable agreement with the predictions from the one-dimensional calculations. If the Th loading in the bottom zone of the outer ring of fuel elements is reduced to the maximum level permitted by space limitations, no major perturbation of the power distribution is expected in either this fuel zone or in the adjacent zones. A control-rod pair, partially inserted in the central patch, results in small perturbations in the power distributions of the adjacent patches and has almost no effect on the rest of the core. (auth)

4377 (NP-16297) CIRCUIT EXPERIMENTAL 10 Mw RAPSODIE: RESULTATS D'EXPLOITATION ET ESSAIS DU POSTE DE STOCKAGE ET D'EPURATION D'ARGON. (10 Mw Rapsodie Experimental Circuit: Results of Operation and Testing the Situation of Storage and Purification of Argon). Delisle, J. P.; Ferrieu, R. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar. 1963. 17p. Dep. mn.

The observations made in the use and test results of Ar storage and purification facilities, which feed the thermal transfer experimental circuit of Rapsodie, are reported. The results showed that the storage and purification devices respond well to the experimental needs of the 10 MW circuit under manual operation. Suggestions are made, on the basis of the test results, for the improvement of a second storage and purification device to be constructed. (J.S.R.)

4378 (NP-16344) PROPOSAL FOR EXPERIMENTAL OPERATION OF THE HBWR FOR THE THREE YEAR PERIOD 1967–1969. (Institutt for Atomenergi, Kjeller (Norway)). Jan. 1966. 120p. Dep. mn.

The proposed program covers continued fuel testing, high fuel heat rating studies, in-core instrument development, thorium physics and fuel studies, water chemistry, and on-line computer control. The characteristics of the third fuel core, stability of HBWR, in-core instrumentation for fuel testing, and handling and inspection facilities for irradiated fuel assemblies are discussed in detail. (D.L.C.)

4379 (NYO-3370-3) CONTROL ROD DRIVE MECHANISM STUDY. TASK III REPORT, PHASE I. Engineering Memorandum No. 3480. Sherwood, Don G. (Westinghouse Electric Corp., Cheswick, Pa. Atomic Equipment Div.). May 12, 1965. Contract AT(30-1)-3370. 91p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

The existing designs of the PM-1 and PM-3A power plants and their operating difficulties were reviewed and conceptual designs and procedures for affecting improvements to the actuators were prepared. (J.R.D.)

4380 (ORNL-TM-1472) MATHEMATICAL MODEL FOR THE HIGH FLUX ISOTOPE REACTOR REACTIVITY CALCULATION. Lawrence, B. R.; Danforth, H. P.; Bullock, J. B. (Oak Ridge National Lab., Tenn.). Oct. 24, 1966. Contract W-7405-eng-26. 27p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

A description is given of a model for calculating expected reactivity changes of the High Flux Isotope Reactor by means of an on-line digital computer. The information provided by the model, together with other information, will be used by the on line computer to grant permission for withdrawal of the reactor shim plates. The model uses effective one-energy group microscopic cross sections obtained from the results of separate, more detailed multigroup space-dependent calculations. Perturbation theory with neutron importance weighting is used to account for marked spatial flux distribution changes during the life of a core. The model was programmed for the CDC-1604 computer, and the calculated reactivity change for operation at full power (using preliminary constants) showed an agreement of 0.5% compared with the multigroup space-dependent results. (auth)

4381 (ORNL-TM-1658) RECOMMENDED FISSION PRODUCT CHAINS FOR USE IN REACTOR EVALUATION STUDIES. Bennett, L. L. (Oak Ridge National Lab., Tenn.). Sept. 26, 1966. Contract W-7405-eng-26. 24p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

A brief review of fission–product poisoning in thermal reactors was made, and a nuclide chain description is recommended for use in reactor evaluation studies at ORNL. Depletion calculations show that this treatment is a satisfactory representation of the time–dependent fission product poisoning. The recommended fission product description treats 26 nuclides explicitly in 11 nuclide chains having a total of 12 interconnecting routes. In addition, two pseudo–elements are used to include the lumped poisoning effects of those nuclides not treated explicitly. Recommended values for yields and cross sections are presented. (auth)

4382 (TID-23381) THEORY OF ROSSI-α EXPERIMENT IN REACTOR NOISE ANALYSIS. Babala, D. (Institutt for Atomenergi, Kjeller (Norway)). June 1966. 24p. (KR-105). Dep. mn. CFSTI $1.00 cy, $0.50 mn

The disagreement between the Rossi-α formula and the conditional count probability, observed by several authors in measurements with a multichannel time analyzer, is explained. It is shown, that the Rossi-α experiments currently performed are of two distinct types, giving different results: the first one is based on measurements of delayed coincidences (Orndoff), the second one employs a multichannel time analyzer, as described in the paper. On the basis of Kolmogorov's general theory of chain processes, a formula for the second type experiment is derived, which is in good agreement with measurements. (tr-auth)

4383 (TID-23383) GARIGLIANO NUCLEAR POWER PLANT. Operation Report for the 2nd Quarter of 1966. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). June 30, 1966. 15p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

After a brief description of the plant condition, an account is given of operation data (electrical outputs, materials consumption, and shutdowns). The core performance is discussed: fuel burnup, pressure drop measurements, and testing. Finally, systems chemistry and health physics data are given. (D.L.C.)

4384 (WCAP-3269-55) CORE PHYSICS CHARACTERISTICS OF THE FIRST LOADING OF THE SAN ONOFRE NUCLEAR GENERATING STATION. Miller, D. L. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Oct. 1966. Contract AT(30-1)-3269. 139p. Dep. mn. CFSTI $4.00 cy, $1.00 mn.

The nuclear design characteristics of the San Onofre first core are presented here. Design data are given for reactivity, power distributions, control by chemical shim and rods, and for all reactivity coefficients. Along with the nuclear characteristics of the San Onofre core, the methods of analysis of these data are presented. Finally, experimental justification of these methods is given where such experimental data exist. (auth)

4385 SAFETY OF NUCLEAR REACTORS AND EVALUATION OF THE STRENGTH OF SHIELDING ENVELOPES. Shershnev, S. T. Sb. Tr. Mosk. Inzh.-Stroitel. Inst., 41: 21-32(1962). (In Russian).

Although containment structures increase capital costs, the need for protection from release of the large amount of radioactivity contained in a power reactor requires their use in densely populated areas. The containment shell must be designed to meet all contingencies in the reactor's operation. Some of the released energy from a reactor accident will be absorbed by the thermal capacity of the entire system; the remainder must be contained by the containment shell. The safety factor is a function of the total energy stored in the reactor system. (J.M.J.)

4386 PRESTRESSED CONCRETE PRESSURE VESSELS FOR NUCLEAR POWER STATIONS. Harris, A. J.; Brown, A. Houghton; Hyde, R. B.; Spruce, T. W.; Hay, J. D. J. Prestressed Concrete Inst., 10: 11p(Oct. 1965).

A report is given of a completed nuclear power station in the United Kingdom using prestressed concrete pressure vessels. With the progression of station capacity and an upward trend in coolant gas pressure, the feasibility of prestressed concrete vessels was investigated. (J.C.W.)

4387 STRUKTUR UND BEEINFLUSSUNGSFAKTOREN DER STROMERZEUGUNGSKOSTEN IN KERNKRAFTWERKEN. (Structure and Influential Factors of Electricity Production Costs in Nuclear Power Stations). Fischer, Klaus-Dieter. Schriftenreihe des Energiewirtschaftlichen Instituts. Band IX. Munich, Verlag Von R. Oldenbourg, 1964. 168p. DM 30.

The cost of energy production in nuclear power plants is analyzed on a broad basis. The effects of the modification of individual cost constituents on influential factors on the height and structure of the total cost were also investigated. (J.S.R.)

4388 NUCLEAR POWER FOR COLORADO. Patterson, L. R.; Walker, R. F. (Public Service Co. of Colorado, Denver). 8p. (CONF-660606-32). ORAU. Gmelin, AED-CONF-66-203-28.

From American Nuclear Society Meeting, Denver, Colo.

The development and progress of the Fort St. Vrain Nuclear Generating Station in Colorado are presented. The high temperature gas-cooled nuclear plant will be in operation in 1971. (J.C.W.)

4389 ANTICIPATED PERFORMANCE OF THE NEW GENERATION OF WATER REACTORS. Wofford, A. W. (Connecticut Yankee Atomic Power Co., Denver). 5p. (CONF-660606-37). ORAU. Gmelin, AED-CONF-66-203-80.

From American Nuclear Society Meeting, Denver, Colo.

Water reactors to furnish low cost fuel now seem realistic. New England has two major projects — the Connecticut Yankee Atomic Power Plant, a pressurized water plant (PWR) and the Millstone Nuclear Power Station, a boiling water plant (BWR). It is expected that reliability will be a main advantage over fossil boilers. (J.C.W.)

4390 ROLE OF PRESSURE VESSEL SURVEILLANCE PROGRAMS IN POWER REACTORS: SUMMARY AND ANALYSIS OF ASME PANEL DISCUSSION. McLaughlin, D. W.; Weissert, L. R. 25p. (CONF-660627-7). ORAU. Gmelin, AED-CONF-66-198-7.

From American Society for Testing and Materials, 69th Annual Meeting, Atlantic City.

Surveillance programs are used to monitor the condition of the pressure vessel steel in power reactors by means of steel specimens placed next to the vessel wall. A panel discussion was held to explore the attitudes, ideas, and programs of representatives of utilities, reactor manufacturers, insurors, and regulatory authorities. After opening statements by each of the representatives, general questions are considered. A summary and analysis of the panel session in the light of more recent events reached the following conclusions: surveillance programs are inspection tools, but they are not research programs; elimination of the programs might be possible if the lifetime exposure level is below a minimum of $\sim 10^{18}$ nvt > 1 MeV; the use of fracture mechanics specimens is questionable; periodic hydrostatic tests of vessels are desirable, especially at a pressure greater than the normal operating pressure and a temperature above the nil-ductility transition temperature. (D.L.C.)

4391 LARGE FAST NUCLEAR REACTOR. Loewenstein, Walter B. (to U. S. Atomic Energy Commission). U. S. Patent 3,287,224. Nov. 22, 1966.

A Na-cooled fast breeder reactor is designed with a core size of at least 800 liters comprising a central core of ^{233}U dispersed in ^{232}Th, an outer core of Pu dispersed in ^{238}U surrounding the inner core, and a blanket of depleted U surrounding the outer core. The reactor operates predominantly on the Pu–^{238}U cycle. (AEC)

4392 UNPURGED FUEL ELEMENT. Zumwalt, Lloyd R. (to U. S. Atomic Energy Commission). U. S. Patent 3,274,066. Sept. 20, 1966.

A patent is described relating to a fuel element for high temperature, gas-cooled nuclear reactors which employs an internal system for the retention and attenuation of fission products. The fuel element includes an elongated outer shell of graphite which is treated to provide a fission product migration-resistant layer of SiC or ZrC, nuclear fuel material, a fission product trap within the shell, and a vent connecting the trap with the exterior of the fuel element to relieve the internal pressure. (auth)

4393 BOILING WATER NUCLEAR REACTOR WITH BUOYANT FUEL OR REFLECTOR CONTROL ASSEMBLY. Gorker, G. E. (to U. S. Atomic Energy Commission). U. S. Patent 3,290,221. Dec. 6, 1966.

A class of boiling water neutronic reactors is described where at least one reactor component or assembly floats in the reactor coolant, and wherein the system reactivity is increased with upward movement of the floating component. (AEC)

4394 NUCLEAR REACTOR FUEL. Jaye, Seymour; Lee, Dana H. Jr. (to U. S. Atomic Energy Commission). U. S. Patent 3,293,135. Dec. 20, 1966.

Fuel for a power-breeder nuclear reactor is described using Th and ^{233}U in segregated fuel units, one of which is coated with pyrolytic carbon. (AEC)

4395 PROCESSES OF PRODUCING ENERGY BY NUCLEAR FISSION. Urey, Harold C.; Cohen, Karl; Barr, Frank T. (to U. S. Atomic Energy Commission). U. S. Patent 3,284,305. Nov. 8, 1966.

This patent is concerned with a heavy water enriched uranium power reactor capable of producing fissionable material. A central chain reacting zone of heavy water and fissionable material is surrounded by a neutron absorbing zone containing heavy water and fertile material. A separation zone is located above the reactor where the steam from both reaction zone and absorber zone is separated from the liquid and solid materials and circulated to a power generating unit. (auth)

4396 NUCLEAR POWER GENERATING APPARATUS. Murphree, Eger V. (to U. S. Atomic Energy Commission). U. S. Patent 3,284,309. Nov. 8, 1966.

This patent is concerned with a power reactor in which the reactor core consists of finely divided enriched U maintained in a fluidized bed in tubes surrounded by heavy water. Heat is extracted from the fluidized U bed and the heavy water and is utilized to provide energy. (auth)

4397 APPARATUS FOR CONTROLLING THE ATMOSPHERE OVER A NUCLEAR REACTOR. Jamrog, Aloysius R. (to U. S. Atomic Energy Commission). U. S. Patent 3,282,793. Nov. 1, 1966.

This patent covers an apparatus for providing an air atmosphere directly over a nuclear reactor in the midst of an Ar atmosphere that is in an extensive chamber generally above the reactor. The apparatus essentially consists of an axially collapsible bellows having one end sealed to the cover of the nuclear reactor and the other end sealed to an opening in the top of the extensive chamber. The bellows protects the electrical controls for the control rods for the reactor from the Ar in the chamber. The air in the bellows permits a worker to descend to the electrical controls for repairing or adjusting them. When used fuel elements in the reactor are to be replaced, the reactor cover is raised to the top opening in the chamber as the bellows is axially collapsed so that the used fuel elements can be lifted out of the reactor into the space in the chamber formerly occupied by the collapsed bellows and moved laterally to a storage rack. (auth)

4398 NUCLEAR FUEL MODULE. Brubaker, J. E. (to U. S. Atomic Energy Commission). U. S. Patent 3,285,821. Nov. 15, 1966.

This patent relates to a compact nuclear fuel module incorporating movable and stationary fuel portions, a shutdown rod, and a dual control drive mechanism for the independent control of the movable fuel portion and the shutdown rod. The drive mechanism is inductively actuated and the movable fuel portion exercises ordinary operating control over the reactor. The dual drive mechanism incorporates a threaded drive tube and inductively driven nut for each movable element in the module. (auth)

4399 METHOD FOR CONTROLLING A NUCLEAR REACTOR BY ABSORBENT GAS AND DEVICE FOR ITS APPLICATION. (to Commissariat a l'Energie Atomique). French Patent 1,316,533. Dec. 23, 1963. Filed Sept. 26, 1962.

The activity of a nuclear reactor is controlled by regulating the degree of pressure of an absorbent gaseous mixture filling a loop placed in the core of the reactor. The corresponding device consists of a reservoir tank filled with a mixture consisting of ^{3}He, an inert gas and a chemical reagent, O_2. The tank is connected to a piping system forming the loop by means of a pressure-reducing valve. The pressure of this valve is controlled according to the

desired reactivity in the reactor. A pump reinjects the gaseous mixture into the tank after the mixture has passed through a vessel in which there takes place the combination of the mixture of H_2 and T_2 on the one hand and O_2 on the other hand. The mixture of light water and T-charged water which have been formed is eliminated in another vessel. A mixture of ^3He and oxygen is introduced into the piping system in stoichiometric proportions so as to replace the quantities of products which have been eliminated. (IIB)

4400 METHOD OF CONTROLLING A NUCLEAR REACTOR PLANT. (to Sulzer Brothers Ltd.). French Patent 1,412,877. Aug. 23, 1965. Priority date Oct. 30, 1963, Sweden.

The rate of supply of medium to the vapor generator is adjusted in dependence upon the vapor temperature dropping below a desired limit and upon the temperature at which the coolant leaves the vapor generator exceeding a desired limit. The adjusting device connected to the temperature detectors consist of two integrating elements, one of which is connected to the vapor temperature detector and the other to the coolant temperature detector. Each integrating element is also connected to a limit-adjusting element. (IIB)

4401 BASE SUPPORT GRID FOR NUCLEAR REACTOR. (to Societe Indatom). French Patent 1,396,470. Mar. 15, 1965. Filed Mar. 11, 1964.

The heat exchanger and the reactor core are located within the same pressure vessel and biological shield. The gases emerging from the core pass downwards through the base plate supporting the core. The plate is made up of at least one horizontal layer of connected bars made of a refractory material, preferably of graphite, and channels for the passage of the cooling gas. A rigid band or girdle surrounds the plate, elastic members being interposed between the surrounding band and the plate so that the connected bars of the plate are placed under compression. In the case of a prestressed concrete pressure vessel, this base support grid can be suspended from the roof of the envelope by means of tie rods which are kept at the core entry temperature of the gas. (IIB)

4402 BOILING WATER NEUTRONIC REACTOR. Gorker, G. E. (to U. S. Atomic Energy Commission). U. S. Patent 3,287,228. Nov. 22, 1966.

A boiling water neutronic reactor is provided wherein water coolant enters the top of the active core region and discharges from the bottom into a lower plenum as a steam–water mixture. The steam separates from the water and travels to a superheater and turbine while the water passes into a collection basin before being recirculated through the core with feedwater returning from the turbine. The water level in the collection basin is maintained within preselected limits by adjusting the core power level so as to balance the feedwater flow rate with the steam generation rate in the core. (AEC)

Rocket and Space Reactors

Refer also to abstract 4403.

4403 THE MPRE: A BOILING POTASSIUM REACTOR SYSTEM. Fraas, Arthur P. (Oak Ridge National Lab., Tenn.). pp 525-40 of Space Power Systems Engineering. New York, Academic Press Inc., 1966.

For a given peak system temperature, a Rankine vapor cycle employing either K or Rb vapor should give the minimum size and weight of the radiator and other major components for turbine-generator nuclear space powerplants. Reliability studies indicated that only by going to the simplest possible system could we achieve the desired reliability. Preliminary system layouts showed that a single-fluid system with the reactor serving as the boiler minimizes the number of components. By eliminating the temperature losses associated with a primary fluid circuit and an intermediate heat exchanger, the single fluid system reduces the peak metal temperature required for a given vapor temperature at the turbine inlet by 200 to 300°F, and makes possible a system weight of about 25 lb/kWe for a stainless steel system with K boiling in the reactor at about 1500°F. A reference design for a launch package has been prepared to serve as the basis for the design of the K system of the reactor experiment. These two systems are compared, and some of their problems — including meteoroid protection and two-phase flow in the condenser — are discussed. (auth)

4404 SAFETY AND RADIATION PROTECTION PROBLEMS OF NUCLEAR POWER SOURCES USED IN SPACE RESEARCH. Makra, Zsigmond. Atomtech. Tajek., 9: 445-52(1966). (In Hungarian).

Radiation protection problems arising from the application of nuclear power sources for space research may be divided in three broad problems: protection of the payload against the radiation from the nuclear power system; protection of the environment against radiation, considering primarily the operating and maintenance personnel; and prevention of the contamination of the environment. Shielding against cosmic radiation represents an additional problem. Contamination may arise as the result of normal operation and as the consequence of an accident. Under normal operation, medium and high-power reactors release considerable amount of fission products. Accidents could have serious consequences. If they occur during or shortly after the launch or as the result of the prompt critical condition when suddenly immersed in water when the space reactor falls into the ocean, the contamination problem is relatively minor but after extended operation, the system may contain a large store of radionuclides. This might be minimized by specifying an orbiting time in space of 10 to 15 half-lives. The chief problem is presented by maintenance operations of nuclear systems after extending operation; specially designed remotely controlled manipulators, more complex than those used in hot cells, must be provided. (TTT)

4405 METHOD AND SYSTEM FOR SUPPLYING THRUST TO A SPACE VEHICLE. Carter, Joseph C.; Rodin, Max B. (to U. S. Atomic Energy Commission). U. S. Patent 3,274,770. Sept. 27, 1966.

A nuclear propulsion system for use in space consisting of a solid-core liquid-metal-cooled nuclear reactor, a beryllium reflector surrounding the reactor, and an irradiation zone surrounding the reflector is described. Molten lithium hydride enriched in lithium-6 is introduced into the irradiation zone and the resulting gas containing products of the reaction between neutrons and lithium-6 is ejected from the irradiation zone to provide thrust. (AEC)

Research and Test Reactors and Critical Assemblies

Refer also to abstract 4382.

4406 (AD-632925) NUCLEAR REACTOR DEVELOPMENT IN EGYPT. Summary of Data. Surak, Anatol (Library of Congress, Washington, D. C. Aerospace Technology Div.). Apr. 1, 1966. 21p. (ATD-66-32). CFSTI $1.00 cy, $0.50 mn.

This summary of data is based on Western open sources published from 1957 through 1965. Available information indicates that Egypt has only one research reactor (supplied by the Soviet Union) and one power reactor (currently under construction). A few nuclear research laboratories are in operation with several more under construction. For the time being, the Egyptian nuclear reactor development program is heavily dependent on foreign cooperation and assistance; however, great emphasis is being placed on the development of a national nuclear engineering capability. The development of the Egyptian Atomic Energy Commission, the abolishment of same, and the subsequent establishment of the Atomic Energy Institute is traced. Names of members of the Atomic Energy Commission, names of scientists employed by the commission, names of assigned specialists, names of members of educational and other special missions sent abroad by the commission, and names of those sent to scientific conferences are listed. The 2-MW research reactor at Inchass and the 150-MW(e) power reactor at Borg-el-Arab are discussed. (D.L.C.)

4407 (ANL-7168(Vol.1)) FAST REACTOR TEST FACILITY (FARET). VOLUME I. DESCRIPTION AND PROGRAM. Geier, J. D. (ed.) (Argonne National Lab., Ill.). Mar. 1966. Contract W-31-109-eng-38. 395p. CFSTI $7.00.

FARET was designed as an experimental 50 MW(t) sodium cooled fast reactor facility. Its salient feature is the capability to irradiate a broad variety of fuels over a wide range of operating conditions. It was designed to permit simultaneous experimental irradiation of large numbers of different fuel elements under controlled variable conditions. It is capable of providing instrumentation within the reactor core to measure the important irradiation parameters. The broad flexibility in operating temperature, flow rate, flux and power density, which is provided permits achieving operating conditions in FARET comparable to those encountered in power reactors. The wide latitude in experimental loading permits experiments to be conducted for the determination of operating parameters related to stability and safety of fast reactors. (auth)

4408 (BNL-10610) HFBR: A SOURCE REACTOR FOR NEUTRON BEAMS. Hendrie, J. M.; Kouts, H. J. C. (Brookhaven National Lab., Upton, N. Y.). Sept. 1966. Contract AT(30-2)-Gen-16. 29p. (CONF-660925-4). Dep. mn. CFSTI $2.00 cy, $0.50 mn.

From Seminar on Intense Neutron Sources, Santa Fe, N. Mex.

The neutron beam facilities of HFBR were described. The heavy water cooled, moderated and reflected reactor was constructed to provide neutrons for physics and chemistry experimentation. The reactor was designed primarily for external neutron beam experiments, and the core, reflector, and beam holes are arranged to enhance the low energy neutron flux in the beams, while decreasing the fast background. Nine of the 16 beam holes are for external beam experiments and the remaining facilities are for irradiation experiments. (J.C.W.)

4409 (EURFNR-73F) THE BEHAVIOR OF FAST ZERO-POWER REACTORS IN THE EVENT OF REACTIVITY PERTURBATIONS. Engelmann, P.; Keller, K. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (West Germany)). Translation of report KFK-332. 64p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

The kinetic and dynamic behavior of fast zero-power reactors was investigated. The object of the work was to obtain a general view of the course of power excursions, the limits of inherently controllable perturbations and the time margin for the intervention of the safety system of SNEAK. The structure of SNEAK is flexible such that it simulates fast reactors of different dimensions, geometry and materials composition. (J.C.W.)

4410 NEUTRON FLUX MEASUREMENTS IN THE ACTIVE ZONE OF VVR-S REACTOR AFTER SHUTDOWN. Lobanov, E. M.; Yankovskii, A. V. (Inst. of Nuclear Physics, Academy of Sciences, Uzbek SSR). Izv. Akad. Nauk Uz. SSR, Ser. Fiz.-Mat. Nauk, No. 4, 35-9(1966). (In Russian).

An attempt was made to determine the yield of neutrons by establishing the relation between complete and differential neutron fluxes and the number of α particles recorded by detectors placed at 90, 135, and 180° with respect to the neutron direction. It was assumed that the distribution of the reaction products is isotropic in the center of mass system; that the deuteron beam is not scattered in the target; and that at the target depth the concentration of the tritium atoms is constant. (R.V.J.)

4411 INFLUENCE OF AN ELECTRIC FIELD ON THE HEAT TRANSFER TO GASEOUS COOLANTS IN A NUCLEAR REACTOR. Berger, Frantisek; Derian, Ladislav (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Acta Tech. CSAV, 10: 312-35(1965).

The application of an electric field increases the transfer of heat from a nuclear fuel element to a gaseous coolant. Experiments in a reactor loop were carried out with CO_2 at 1, 1,5 and 2 atmospheres and with air at 2 atmospheres. The Al channel containing the stainless steel heating element was inserted in the WWRS reactor core. The element was negative and the lower section of the inner tube formed the anode to 4800 volts. With the cooling circuits closed, the electric field influence was determined at gas velocities to 25 m/s, reactor outputs to 2600 kW and voltages between the electrodes to 3000 dc. The heat transfer α was shown to increase with a voltage increase and 40% by the influence of an electric field. An increase in α is a function of the saturation of the current and on the gas properties used in Ri. Heat transfer increases as the gas pressure increases. (J.C.W.)

Reactor Components, Fuels and Accessories

Refer also to abstracts 3207 and 3474.

4412 (BNWL-314) PLUTONIUM UTILIZATION PROGRAM: PRTR IRRADIATION PLANS. Freshley, M. D.; Sharp, R. E.; Skavdahl, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1966. Contract AT(45-1)-1830. 19p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

An account is given of the irradiation plans for determining the performance capabilities of Pu-enriched oxide fuels. The plans include tests in the PRTR High Power Density Core during the Batch Core Experiment and in the Fuel Element Rupture Test Facility (FERTF) of PRTR. The Batch Core tests will gather information on UO_2-PuO_2 fuel elements up to 20,000 MWd/mt. The FERTF tests will be on nondefected and defected fuel rods at rod powers of 20, 24, and 28 kW/ft. (D.L.C.)

4413 (GEAP-5174) ACCURATE NUCLEAR FUEL BURNUP ANALYSES. Quarterly Progress Report No. 18, March-May 1966. Rider, B. F.; Ruiz, C. P.; Peterson, J. P. Jr.; Smith, F. R. (General Electric Co., Pleasanton, Calif. Vallecitos Atomic Lab.). June 1, 1966. Contract AT(04-3)-189. 61p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Four ASTM methods on fuel burnup analysis have either been written or revised. The principal effort was placed on simplification of the ^{148}Nd method to help increase the use of this method. (auth)

4414 (TID-23382) INTERVAL DISTRIBUTIONS OF REACTOR NEUTRON COUNTS. Babala, D. (Institutt for Atomenergi, Kjeller (Norway)). Sept. 1966. 13p. (KR-106). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Formulas for interval distributions of neutron counts, which open possibilities for new methods of reactor noise measurements, are derived. The proposed experimental techniques promise to be less time consuming than the zero probability method of Mogilner and Zolotukhin. The useful information contained in a sequence of counts lies in its deviation from Poisson statistics. The magnitude of this deviation depends either on the counter efficiency or on the intensity of the external neutron source. From this point of view, the techniques of noise measurements can be divided into two groups: the "efficiency sensitive" methods (Feynman) and the "power sensitive" methods (Rossi-α). The proposed count-to-count interval distribution measurement seems to combine the advantages of both groups. (tr-auth)

4415 STUDY OF CERTAIN PECULIARITIES OF OPERATION OF GAS DETECTORS OPERATING IN AN ELECTRONIC SYSTEM. APPLICATION TO REACTOR CONTROL. Bonnet, G.; Delcroix, V.; Mai, V. Q. (CEA-CEN, Grenoble, France). Nucl. Instrum. Methods, 45: 87-92(Nov.-Dec. 1966). (In French).

The use in reactor control of pulse channels working at higher and higher rates has shown a very particular effect. At high levels and high discriminator threshold setting, the counting rate increases faster than the reactor power. A simple explanation of this effect is given. (auth)

4416 FRENCH EXPERIMENTAL RESEARCH IN CRITICALITY. Clouet d'Orval, C.; Deilgat, E.; Houelle, M.; Lecorche, P. (CEA, Paris). 24p. (In French). (CONF-651103-27; SM-70/21). ORAU.

From IAEA Symposium on Criticality Control of Fissile Materials, Stockholm.

The experimental facilities available at Saclay and at Balduc for criticality studies are briefly described. The experimental program is outlined. (J.S.R.)

4417 DEVICE FOR TRANSFERRING USED FUEL. Komai, Kenichiro (to Hitachi Ltd.). Japanese Patent 1965-8960. Mar. 22, 1965. Filed Mar. 27, 1962.

The device proposed can be used very suitably for a nuclear reactor of the double containment vessel-type. In the upper part of the inner vessel, a fuel-handling water tank is installed, and at a part of the periphery of the outer vessel, a spent-fuel storage tank is installed. The device proposed is used for transferring a used fuel from the water tank to the storage tank. When the fuel container receives or discharges a used fuel, it takes the vertical position, thereby making the handling easier. When passing through the vessel walls, it lies flat, thereby making small the cross section of these passages; this brings about an advantage in the strength design of the containment vessels. All the transfer operation is done automatically, and in a water shielding. In consequence, the method proposed is safe and is free from the fear of the breakage of used fuel elements. The water tank and the storage tank are connected by a transfer passage. This passage has rails, and a carriage running along the rails, this carriage has a rotatable spent fuel container. Outside and inside of both the inner and outer vessels is installed a device for standing and falling flat the spent fuel container. (NSA of Japan)

4418 LOADING AND UNLOADING DEVICE FOR A NUCLEAR REACTOR. (to Electricite de France). French Patent 1,394,084. Feb. 22, 1965. Filed Jan. 9, 1964.

A vertical stationary distributing tube connects a horizontal working surface of a gas-cooled nuclear reactor to an array of ducts rigidly connected to the distributing tube. Each duct provides a path between one channel and the distributing tube via an aperture in the distributing tube wall. A routing assembly is inserted in the distributing tube and is automatically adjusted in longitudinal and angular position for communicating the tube with one of the ducts by means of abutment and orientation organs fixed in the distributing tube. (IIB)

4419 HANDLING APPARATUS FOR NUCLEAR REACTOR REFUELLING FACILITY. (to Commissariat a l'Energie Atomique). French Patent 1,400,440. Apr. 20, 1965. Filed Apr. 9, 1964.

A refueling facility is designed in such a way, that the fuel can be inserted from a servicing chamber into the channels of the reactor core and withdrawn first from the core, then from the servicing chamber even when the reactor is operating at full

pressure. The apparatus comprises an arm which is rotatable about a vertical axis within a servicing chamber provided within the reactor pressure vessel and biological shield. A fuel element handling machine is movable along a guide track carried by the arm and downwardly inclined from the vertical axis towards the periphery. The radially inward movement of the handling machine is controlled by driving means whilst the radially outward movements take place under the action of gravity. (IIB)

4420 FAST REACTOR FUEL. Thoma, R. E. (to U. S. Atomic Energy Commission). U. S. Patent 3,287,278. Nov. 22, 1966.

A fast reactor fuel composition comprises substantially 30 mole % of a metal chloride selected from the group consisting of UCl_3, $PuCl_3$, and mixtures thereof, substantially 40 mole % KCl, and substantially 30 mole % NaCl. The fuel composition has a liquidus temperature below about 485°C. (AEC)

4421 FUEL ELEMENT. Fortescue, Peter (to U. S. Atomic Energy Commission). U. S. Patent 3,291,698. Dec. 13, 1966.

A nuclear reactor fuel element is described which provides for thermal expansion of the fuel. It is a tubular element having two sections; a lower circular section containing the fuel and a fluid heat transfer material and an upper flattened section capable of expansion. (AEC)

4422 PERIOD METER FOR A NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,304,184. Aug. 13, 1962. Filed Aug. 11, 1961.

A logarithmic amplifier is adapted to receive a current from a neutron ionization chamber compensated for gamma radiations. The amplifier supplies an output voltage which is proportional to the logarithm of this current. A differentiating amplifier is adapted to supply a voltage proportional to the time derivative of the output voltage of the logarithmic amplifier. The differentiating amplifier, which effects primarily a differentiation, is adapted to effect also an auxiliary integration whereby the fluctuations of the output voltage are reduced. The integration results in a response time which is continuously and automatically variable both in accordance with the actual period of the reactor and in accordance with the neutron flux. The response time is relatively great when the neutron power is low and relatively small when the neutron power is high. This arrangement permits having a small response time in all the dangerous situations of the reactor, and a satisfactory signal/noise ratio in all normal situations. (IIB)

4423 METHOD OF MANUFACTURING CONTROL RODS FOR NUCLEAR REACTORS. (to Allmaenna Svenska Elektriska Aktiebolaget). French Patent 1,334,647. July 1, 1963. Priority date Sept. 11, 1961, Sweden.

An element of a neutron absorbing material, comprising a silver-base alloy containing Cd and/or In, is cladded on surfaces subjected to mechanical and chemical stresses with a layer of steel. The steel layer with a thin layer of copper attached thereto, is applied in contact with the element of neutron absorbing material with the copper layer turned towards the element. The element and the steel layer are subjected to heat treatment at a temperature of at least 500°C, but not above the temperature at which the pure neutron absorbing material begins to melt. During the heat treatment, a liquid phase of copper and neutron absorbing material occurs at the contact surface. On subsequent cooling, this phase acts as a strong connecting link between the adjacent materials. (IIB)

4424 PNEUMATIC MEANS FOR BRAKING THE END OF FALL OF A REACTOR CONTROL ROD. (to Groupement Atomique Alsacienne Atlantique). French Patent 1,300,805. July 2, 1962. Filed June 15, 1961.

The control rod is fixed to the piston of a pneumatic jack by means of a hollow rod having holes at a point near its connection to the control rod and another set of holes longitudinally spaced therefrom and near its connection to the piston. The spacing is a function of the distance through which the rod falls. An orifice is provided near the base of the cylinder wall of the jack, communicating through a non-return valve with a tank. During the accelerated part of the piston fall, the gas that is expelled by the piston as it drops from its upper position, escapes through holes in the hollow rod and the orifice. Towards the end of the fall the free escape of gas is no longer possible, because it can escape only through the calibrated orifice. Thus, the gas under the piston is compressed and absorbs the kinetic energy of the rod. (IIB)

4425 NUCLEAR REACTOR LOADING AND UNLOADING MACHINE. (to Electricite de France). French Patent 1,395,856. Mar. 8, 1965. Filed Mar. 6, 1964.

The loading and unloading machine is adapted to be sealingly connected to standpipes opening in the pressure vessel of a gas-cooled reactor. The machine comprises on the one hand, two subassemblies each bounding a sealed chamber and each provided with a shield forming part of the biological protection against the radiation of the fuel elements contained in the machine. Each shield is formed with a gap while the bottom subassembly is adapted for coupling to the standpipe and the top subassembly is adapted for sealing-tight coupling to the bottom subassembly in a position such that the gaps register with one another. Two radiation-absorbent elements are placed in such a way, that the first is locked to the top subassembly during relative displacement of the two subassemblies in a transverse direction with respect to the gaps and is locked to the bottom subassembly when it is situated level with the gap in the shield in the bottom subassembly. The second radiation-absorbent element is locked to the bottom subassembly during the mentioned displacement and locked to the top subassembly when it is situated level with the gap in the shield thereof. (IIB)

GENERAL

4426 (ANL-7149) GYRO II: A MACRO-DEFINED SYSTEM FOR LIST PROCESSING. Carson, Daniel F.; Robinson, George A. (Argonne National Lab., Ill.). May 1966. Contract W-31-109-eng-38. 38p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

A formal description of the GYRO II language is presented and the implementation for the Control Data 3600 at Argonne National Laboratory is discussed. (B.G.D.)

4427 (ORNL-4005) BIASES OF ESTIMATORS FOR THE NEGATIVE BINOMIAL DISTRIBUTION. Bowman, K. O.; Shenton, L. R. (Oak Ridge National Lab., Tenn.). Nov. 1966. Contract W-7405-eng-26. 126p. Dep. mn, CFSTI $3.00 cy, $0.65 mn.

The parametric form of the negative binomial distribution considered has mean pk and variance pk(p + 1) and probability generating function $(1 + p - pt)^{-k}$. It is well known that the maximum likelihood estimators $\hat{p}$, $\hat{k}$ of p, k are biased. If the sample size is n the biases may be expanded as series in descending powers of n, the higher order terms being almost impossible to find. Here we give a tabulation of the terms in the series depending on n^{-1} and n^{-2}. The table may also be used for the asymptotic biases of two other well known parametrizations. (auth)

4428 (ORNL-4031) CONTOUR, A FORTRAN SUBROUTINE FOR PRODUCING CONTOUR MAPS. Branstetter, E. E. (Oak Ridge National Lab., Tenn.). Nov. 1966. Contract W-7405-eng-26. 24p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

A FORTRAN-63 program to produce a contour map of a function f(x,y) of two variables is described. It has been written for use with the CDC 1604A computer and the Calcomp 580 incremental plotter system. The function f must be defined and single-valued in a rectangular domain in the x-y plane and f must be known at discrete points equally spaced in each coordinate direction of this domain. The curves f(x,y) = c determined by the intersection of this function f and planes parallel to the x-y plane at specified levels (values of c) are located and represented as sequences of x-y coordinates. A contour map is produced by plotting on the same graph the line segments connecting the coordinates of each sequence and making suitable identifications. (auth)

4429 (UCRL-16806, pp 15-16) LOCALIZATION OF CHLOROPHYLL IN SPINACH CHLOROPLAST LAMELLAE BY FLUORESCENCE AND ELECTRON MICROSCOPY. Lintilhac, P.; Park, Roderic B. (California Univ., Berkeley. Lawrence Radiation Lab.).

Chlorophyll in green plants is generally thought to reside in the internal membranes of lamellae of chloroplasts. These membranes are observable by electron microscopy, and can be roughly grouped on the basis of size and arrangement into grana and stroma lamellae. These lamellae exist as closed, flattened sacs or thylakoids. Although the chlorophyll molecule itself is not demonstrable by electron microscopy, it is readily detected by fluorescence microscopy. A technique is described for the observation of the same specimen by fluorescence and electron microscopy, yields precise information on the distribution of chlorophyll in the membranes through a direct comparison of ultrastructure and fluorescence. (C.H.)

4430 (UCRL-16806, pp 34-8) HEREDITY, ENVIRONMENT, LEARNING, AND THE BRAIN. Bennett, Edward L.; Hebert, Marie; Morimoto, Hiromi; Orme, Ann (California Univ., Berkeley. Lawrence Radiation Lab.).

Experiments on rats raised in isolation (IC) and those raised in a behaviorally enriched environment (ECT rats) showed that anatomical and chemical characteristics of a rat's brain can be changed by the behavioral environment. The ECT rat has a heavier cortex, lower AChE activity/mg, and higher ChE activity/mg. The ECT rat has a higher cortex-to-subcortex weight ratio and a higher cortical-to-sub-cortical ratio of ChE to AChE. The ECT rat also has a thicker cortex, a higher glia-neuron ratio, and perhaps greater dendritic branching than his IC littermate. Similar environmental enrichment enhances learning ability in a Visual Reversal Discrimination Test. The characteristic weight and chemical pattern found when ECT rats are compared with IC rats is also found in comparisons between bright and dumb strains. Taken together, all of these results suggest a chemical and anatomical basis for the learning ability of the rat. (C.H.)

4431 (UCRL-16806, pp 42-3) PRODUCTION OF CYSTEIC ACID, TAURINE, AND CYSTAMINE UNDER PRIMITIVE EARTH CONDITIONS. Choughuley, Ahmed S. U.; Lemmon, Richard M. (California Univ., Berkeley. Lawrence Radiation Lab.).

It is now well established that most of the simple, biologically important monomers (such as amino acids, pentoses, purines, and fatty acids) are formed when various high-energy sources are applied to samples of the primitive Earth's atmosphere. This atmosphere is assumed to consist mainly of CH_4, H_2O, NH_3, N_2, and H_2 (the last decreasing rapidly with increased age of the Earth). Results are reported from a search for the primitive-Earth synthesis of S-containing amino acids using $H_2{}^{35}S$ as one of the reactants, thus greatly increasing the detection sensitivity for an amino acid product. The appearance of cysteic acid, $HO_3SCH_2CH(NH_2)CO_2H$, and the closely related compounds taurine, $HO_3SCH_2CH_2NH_2$, and cystamine, $(SCH_2CH_2NH_2)_2$ was established. Cysteine and cystine probably were formed (there was evidence for them in early chromatograms), but they appeared to be oxidized to cysteic acid during subsequent chromatography. No evidence was found for methionine production. In each of the three experiments reported, 20 ml of 2N NH_4OH, 200 mm of CH_4, and 100 mm of $H_2{}^{35}S$ (containing 5 mcurie) were placed in a Pyrex tube and irradiated, with an electron beam, at a radiation dose of about 10^9 rads in the absence of air. The following ^{35}S-labeled products (yield from $H_2{}^{35}S$ given parenthetically) were positively identified: cysteic acid (0.01%), cystamine (0.003%), and taurine (0.01%). Cysteine, cystine, and methionine were not found. (C.H.)

4432 (UCRL-16806, pp 44-52) MECHANISM AND PROTO-BIOCHEMICAL RELEVANCE OF DICYANAMIDEMEDIATED PEPTIDE SYNTHESIS. Steinman, Gary; Kenyon, Dean H.; Calvin, Melvin (California Univ., Berkeley. Lawrence Radiation Lab.).

The mechanism by which dicyanamide (DCA) promotes the synthesis of diglycine from glycine in aqueous solution was investigated in detail using carbon-14 and tritium-labeled compounds. It was found that protonation of both dicyanamide anion and the glycine carboxylate group are required for dipeptide synthesis. Peptide bond formation is apparently initiated by reaction of the glycine carboxyl group with dicyanamide to form an unstable intermediate which undergoes nucleophilic attack by the amino group of a second glycine molecule, resulting in the production of diglycine and cyanurea. N-cyano-N'-glycyl-urea occurs in the reaction mixture as a prominent side product, suggesting that DCA induces peptide bond formation via an intermediate similar to that postulated in the case of the dialkylcarbodiimides. The possible role of DCA-mediated polypeptide synthesis in prebiological chemical evolution is discussed. (C.H.)

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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 4634 and 5505.

4433 (ANL-7125, pp 241-3) ANALYTICAL RESEARCH AND DEVELOPMENT. Larsen, R. P.; Meyer, R. J. (Argonne National Lab., Ill.).

A program for the development of analytical methods for the determination of burnup of fast reactor fuels and for the measurement of fast fission yields is being carried out. The determination of total rare earths is being considered as a means of measuring burnup. Using a complexiometric titration with ethylenediaminetetraacetic acid, 500 μg of rare earths have been determined with an accuracy of ±0.5%. At the 50-μg level, the accuracy is ±2%. The use of neutron activation for determining the fast fission yield of praseodymium-141 and other stable fission nuclides is also being investigated. Preliminary results indicate that this measurement can be made with an accuracy of ±1%. (auth)

4434 (IDO-14678) BURNUP DETERMINATION OF NUCLEAR FUELS. Project Report for the Quarter January 1-March 31, 1966. Maeck, William J.; Lisman, Frederick L.; Rein, James E. (eds.) (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Oct. 1966. Contract AT(10-1)-205. 23p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Measurements were made of the α (capture-to-fission ratio) for U-233 and U-235. Two capsules containing a known amount of highly enriched U-235 and four capsules containing a known amount of highly enriched U-233 were irradiated in the MTR and subsequently analyzed for total and isotopic uranium concentration. Based on these data, tentative effective $\hat{\alpha}$ values (at a Cd ratio for Co = 15) and the computed 2200 m/sec values are: 0.0997 ± 0.0016 and 0.0984 ± 0.0016 for U-233, and 0.1768 ± 0.0015 and 0.1716 ± 0.0015 for U-235, respectively. (auth)

4435 (NP-16396) THE DETERMINATION OF ZIRCONIUM, NIOBIUM, AND HAFNIUM IN LOW ALLOY STEELS BY X-RAY SPECTROGRAPHY. Reed, Dorothy J. (Department of Mines and Technical Surveys (Canada). Mines Branch). Dec. 1965. 27p. (R-174). Dep. mn. Dept. of Mines and Technical Surveys, Ottawa $0.75.

Zirconium, niobium, and hafnium were determined in mild steels by x-ray spectrography in amounts up to 0.35, 0.30, and 0.20%, respectively, with errors of less than ±0.01%. Because suitable standards for zirconium and niobium were unavailable and no standards for hafnium existed, it was necessary to use synthetic standards. A number of samples were set up as Mines Branch secondary standards and the validity of their use was verified. Using accelerating potentials of 80 or 90 kV, zirconium and niobium may be determined in the ppM range. The sensitivity for hafnium is 0.01%. (auth)

4436 (ORNL-P-2690) FORENSIC APPLICATIONS OF TRACE ELEMENTS IN HAIR. Bate, L. C.; Dyer, F. F. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 18p. (CONF-660937-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From International Conference on Forensic Activation Analysis, San Diego, Calif.

Factors affecting identification in the analysis of hair for trace elements in criminal cases and methods for eliminating these factors are discussed. Recommendations are given concerning further studies on hair comparisons. (P.C.H.)

4437 (UCRL-17071) INVESTIGATION OF THE OXYGEN AND CARBON CONTAMINATION OF SOME LANTHANIDE AND ACTINIDE METALS. Lowenhaupt, Edward Harris (California Univ., Berkeley. Lawrence Radiation Lab.). May 5, 1965. Contract W-7405-eng-48. 58p. DTIE.

Thesis.

An activation analysis technique employing ^{3}He-induced nuclear reactions was used in a study of the oxygen and carbon contents of some lanthanide and actinide metals. Experimental application of the technique was refined. Its reliability within the limits of oxygen concentration encountered in this study was investigated, and an approximation, which introduced errors of greater than 50% in some cases in the calculation of results, was eliminated. The oxygen and carbon content of metals produced by reduction of their respective trifluorides with barium vapor was studied to determine the ability of some drying techniques to remove these elements from the trifluorides. Metals produced from untreated trifluorides contain about 6000 ppM oxygen. Metals produced from trifluorides treated with anhydrous HF gas were found to contain as little as 300 to 400 ppM oxygen. (auth)

4438 (UCRL-50115) GRAPHICAL REPRESENTATIONS OF SELECTED FUNCTIONS OF INTERPLANAR SPACINGS FOR 5184 INORGANIC X-RAY POWDER DIFFRACTION PATTERNS. Nichols, Monte C. (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 4, 1966. Contract W-7405-eng-48. 11p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Graphical representations of the distributions of strong d-spacings for 5184 inorganic mineral and nonmineral x-ray powder diffraction patterns are given. The bimodal character exhibited by some of the distributions is discussed. The usefulness and limitations of the Hanawalt scheme for identification using the ASTM file are discussed in the light of the distributions presented. The method of the inverse match (comparison of standard patterns with an unknown pattern, rather than unknown pattern with standard patterns) and its application to computer search techniques are discussed. (auth)

4439 (UCRL-70056) CATHODIC ETCHING TO PREPARE METALS FOR OXYGEN DETERMINATION. Hill, John H.; Morris, C. J.; Frazer, Jack W. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 18, 1966. Contract W-7405-eng-48. 7p. (CONF-661008-1). DTIE.

From 1st Materials Research Symposium on Trace Characterization: Chemical and Physical, Gaithersburg, Md.

A cathodic etching method was developed to clean the surfaces of metal samples prior to oxygen determinations. The sample becomes the cathode in a low pressure argon-ion discharge. Argon ions bombard the surface of the sample and remove the oxide film by an etching process. The oxygen content of metal samples cleaned by cathodic etching is consistently lower than the oxygen content of samples cleaned by filing. In addition, contamination from radioactive samples is minimized because the sputtered metal deposits on surfaces inside the etcher assembly. (auth)

4440 (Y-KG-36) HIGHLIGHTS OF THE Y-12 BIOANALYSIS LABORATORY OPERATION. Kent, R. H. (Oak Ridge National Lab., Tenn.). Oct. 10, 1966. Contract W-7405-eng-26. 9p. (CONF-661018-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 12th Annual Bioassay and Analytical Chemistry Meeting, Gatlinburg, Tenn.

Procedures are described for the determination of enriched uranium, mercury, and ^{210}Po in human urine on a large scale. The procedures generally are economical and involve only a short time. (P.C.H.)

From Seminar on Intense Neutron Sources, Santa Fe, N. Mex.

The neutron beam facilities of HFBR were described. The heavy water cooled, moderated and reflected reactor was constructed to provide neutrons for physics and chemistry experimentation. The reactor was designed primarily for external neutron beam experiments, and the core, reflector, and beam holes are arranged to enhance the low energy neutron flux in the beams, while decreasing the fast background. Nine of the 16 beam holes are for external beam experiments and the remaining facilities are for irradiation experiments. (J.C.W.)

4409 (EURFNR-73F) THE BEHAVIOR OF FAST ZERO-POWER REACTORS IN THE EVENT OF REACTIVITY PERTURBATIONS. Engelmann, P.; Keller, K. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (West Germany)). Translation of report KFK-332. 64p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

The kinetic and dynamic behavior of fast zero-power reactors was investigated. The object of the work was to obtain a general view of the course of power excursions, the limits of inherently controllable perturbations and the time margin for the intervention of the safety system of SNEAK. The structure of SNEAK is flexible such that it simulates fast reactors of different dimensions, geometry and materials composition. (J.C.W.)

4410 NEUTRON FLUX MEASUREMENTS IN THE ACTIVE ZONE OF VVR-S REACTOR AFTER SHUTDOWN. Lobanov, E. M.; Yankovskii, A. V. (Inst. of Nuclear Physics, Academy of Sciences, Uzbek SSR). Izv. Akad. Nauk Uz. SSR, Ser. Fiz.-Mat. Nauk, No. 4, 35-9(1966). (In Russian).

An attempt was made to determine the yield of neutrons by establishing the relation between complete and differential neutron fluxes and the number of α particles recorded by detectors placed at 90, 135, and 180° with respect to the neutron direction. It was assumed that the distribution of the reaction products is isotropic in the center of mass system; that the deuteron beam is not scattered in the target; and that at the target depth the concentration of the tritium atoms is constant. (R.V.J.)

4411 INFLUENCE OF AN ELECTRIC FIELD ON THE HEAT TRANSFER TO GASEOUS COOLANTS IN A NUCLEAR REACTOR. Berger, Frantisek; Derian, Ladislav (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Acta Tech. CSAV, 10: 312-35(1965).

The application of an electric field increases the transfer of heat from a nuclear fuel element to a gaseous coolant. Experiments in a reactor loop were carried out with CO_2 at 1, 1,5 and 2 atmospheres and with air at 2 atmospheres. The Al channel containing the stainless steel heating element was inserted in the WWRS reactor core. The element was negative and the lower section of the inner tube formed the anode to 4800 volts. With the cooling circuits closed, the electric field influence was determined at gas velocities to 25 m/s, reactor outputs to 2600 kW and voltages between the electrodes to 3000 dc. The heat transfer α was shown to increase with a voltage increase and 40% by the influence of an electric field. An increase in α is a function of the saturation of the current and on the gas properties used in Ri. Heat transfer increases as the gas pressure increases. (J.C.W.)

Reactor Components, Fuels and Accessories

Refer also to abstracts 3207 and 3474.

4412 (BNWL-314) PLUTONIUM UTILIZATION PROGRAM: PRTR IRRADIATION PLANS. Freshley, M. D.; Sharp, R. E.; Skavdahl, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1966. Contract AT(45-1)-1830. 19p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

An account is given of the irradiation plans for determining the performance capabilities of Pu-enriched oxide fuels. The plans include tests in the PRTR High Power Density Core during the Batch Core Experiment and in the Fuel Element Rupture Test Facility (FERTF) of PRTR. The Batch Core tests will gather information on UO_2–PuO_2 fuel elements up to 20,000 MWd/mt. The FERTF tests will be on nondefected and defected fuel rods at rod powers of 20, 24, and 28 kW/ft. (D.L.C.)

4413 (GEAP-5174) ACCURATE NUCLEAR FUEL BURNUP ANALYSES. Quarterly Progress Report No. 18, March–May 1966. Rider, B. F.; Ruiz, C. P.; Peterson, J. P. Jr.; Smith, F. R. (General Electric Co., Pleasanton, Calif. Vallecitos Atomic Lab.). June 1, 1966. Contract AT(04-3)-189. 61p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Four ASTM methods on fuel burnup analysis have either been written or revised. The principal effort was placed on simplification of the ^{148}Nd method to help increase the use of this method. (auth)

4414 (TID-23382) INTERVAL DISTRIBUTIONS OF REACTOR NEUTRON COUNTS. Babala, D. (Institutt for Atomenergi, Kjeller (Norway)). Sept. 1966. 13p. (KR-106). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Formulas for interval distributions of neutron counts, which open possibilities for new methods of reactor noise measurements, are derived. The proposed experimental techniques promise to be less time consuming than the zero probability method of Mogilner and Zolotukhin. The useful information contained in a sequence of counts lies in its deviation from Poisson statistics. The magnitude of this deviation depends either on the counter efficiency or on the intensity of the external neutron source. From this point of view, the techniques of noise measurements can be divided into two groups: the "efficiency sensitive" methods (Feynman) and the "power sensitive" methods (Rossi-α). The proposed count-to-count interval distribution measurement seems to combine the advantages of both groups. (tr-auth)

4415 STUDY OF CERTAIN PECULIARITIES OF OPERATION OF GAS DETECTORS OPERATING IN AN ELECTRONIC SYSTEM. APPLICATION TO REACTOR CONTROL. Bonnet, G.; Delcroix, V.; Mai, V. Q. (CEA-CEN, Grenoble, France). Nucl. Instrum. Methods, 45: 87-92(Nov.-Dec. 1966). (In French).

The use in reactor control of pulse channels working at higher and higher rates has shown a very particular effect. At high levels and high discriminator threshold setting, the counting rate increases faster than the reactor power. A simple explanation of this effect is given. (auth)

4416 FRENCH EXPERIMENTAL RESEARCH IN CRITICALITY. Clouet d'Orval, C.; Deilgat, E.; Houelle, M.; Lecorche, P. (CEA, Paris). 24p. (In French). (CONF-651103-27; SM-70/21). ORAU.

From IAEA Symposium on Criticality Control of Fissile Materials, Stockholm.

The experimental facilities available at Saclay and at Balduc for criticality studies are briefly described. The experimental program is outlined. (J.S.R.)

4417 DEVICE FOR TRANSFERRING USED FUEL. Komai, Kenichiro (to Hitachi Ltd.). Japanese Patent 1965-8960. Mar. 22, 1965. Filed Mar. 27, 1962.

The device proposed can be used very suitably for a nuclear reactor of the double containment vessel-type. In the upper part of the inner vessel, a fuel-handling water tank is installed, and at a part of the periphery of the outer vessel, a spent-fuel storage tank is installed. The device proposed is used for transferring a used fuel from the water tank to the storage tank. When the fuel container receives or discharges a used fuel, it takes the vertical position, thereby making the handling easier. When passing through the vessel walls, it lies flat, thereby making small the cross section of these passages; this brings about an advantage in the strength design of the containment vessels. All the transfer operation is done automatically, and in a water shielding. In consequence, the method proposed is safe and is free from the fear of the breakage of used fuel elements. The water tank and the storage tank are connected by a transfer passage. This passage has rails, and a carriage running along the rails, this carriage has a rotatable spent fuel container. Outside and inside of both the inner and outer vessels is installed a device for standing and falling flat the spent fuel container. (NSA of Japan)

4418 LOADING AND UNLOADING DEVICE FOR A NUCLEAR REACTOR. (to Electricite de France). French Patent 1,394,084. Feb. 22, 1965. Filed Jan. 9, 1964.

A vertical stationary distributing tube connects a horizontal working surface of a gas-cooled nuclear reactor to an array of ducts rigidly connected to the distributing tube. Each duct provides a path between one channel and the distributing tube via an aperture in the distributing tube wall. A routing assembly is inserted in the distributing tube and is automatically adjusted in longitudinal and angular position for communicating the tube with one of the ducts by means of abutment and orientation organs fixed in the distributing tube. (IIB)

4419 HANDLING APPARATUS FOR NUCLEAR REACTOR REFUELLING FACILITY. (to Commissariat a l'Energie Atomique). French Patent 1,400,440. Apr. 20, 1965. Filed Apr. 9, 1964.

A refueling facility is designed in such a way, that the fuel can be inserted from a servicing chamber into the channels of the reactor core and withdrawn first from the core, then from the servicing chamber even when the reactor is operating at full

pressure. The apparatus comprises an arm which is rotatable about a vertical axis within a servicing chamber provided within the reactor pressure vessel and biological shield. A fuel element handling machine is movable along a guide track carried by the arm and downwardly inclined from the vertical axis towards the periphery. The radially inward movement of the handling machine is controlled by driving means whilst the radially outward movements take place under the action of gravity. (IIB)

4420 FAST REACTOR FUEL. Thoma, R. E. (to U. S. Atomic Energy Commission). U. S. Patent 3,287,278. Nov. 22, 1966.

A fast reactor fuel composition comprises substantially 30 mole % of a metal chloride selected from the group consisting of UCl_3, $PuCl_3$, and mixtures thereof, substantially 40 mole % KCl, and substantially 30 mole % NaCl. The fuel composition has a liquidus temperature below about 485°C. (AEC)

4421 FUEL ELEMENT. Fortescue, Peter (to U. S. Atomic Energy Commission). U. S. Patent 3,291,698. Dec. 13, 1966.

A nuclear reactor fuel element is described which provides for thermal expansion of the fuel. It is a tubular element having two sections; a lower circular section containing the fuel and a fluid heat transfer material and an upper flattened section capable of expansion. (AEC)

4422 PERIOD METER FOR A NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,304,184. Aug. 13, 1962. Filed Aug. 11, 1961.

A logarithmic amplifier is adapted to receive a current from a neutron ionization chamber compensated for gamma radiations. The amplifier supplies an output voltage which is proportional to the logarithm of this current. A differentiating amplifier is adapted to supply a voltage proportional to the time derivative of the output voltage of the logarithmic amplifier. The differentiating amplifier, which effects primarily a differentiation, is adapted to effect also an auxiliary integration whereby the fluctuations of the output voltage are reduced. The integration results in a response time which is continuously and automatically variable both in accordance with the actual period of the reactor and in accordance with the neutron flux. The response time is relatively great when the neutron power is low and relatively small when the neutron power is high. This arrangement permits having a small response time in all the dangerous situations of the reactor, and a satisfactory signal/noise ratio in all normal situations. (IIB)

4423 METHOD OF MANUFACTURING CONTROL RODS FOR NUCLEAR REACTORS. (to Allmaenna Svenska Elektriska Aktiebolaget). French Patent 1,334,647. July 1, 1963. Priority date Sept. 11, 1961, Sweden.

An element of a neutron absorbing material, comprising a silver-base alloy containing Cd and/or In, is cladded on surfaces subjected to mechanical and chemical stresses with a layer of steel. The steel layer with a thin layer of copper attached thereto, is applied in contact with the element of neutron absorbing material with the copper layer turned towards the element. The element and the steel layer are subjected to heat treatment at a temperature of at least 500°C, but not above the temperature at which the pure neutron absorbing material begins to melt. During the heat treatment, a liquid phase of copper and neutron absorbing material occurs at the contact surface. On subsequent cooling, this phase acts as a strong connecting link between the adjacent materials. (IIB)

4424 PNEUMATIC MEANS FOR BRAKING THE END OF FALL OF A REACTOR CONTROL ROD. (to Groupement Atomique Alsacienne Atlantique). French Patent 1,300,805. July 2, 1962. Filed June 15, 1961.

The control rod is fixed to the piston of a pneumatic jack by means of a hollow rod having holes at a point near its connection to the control rod and another set of holes longitudinally spaced therefrom and near its connection to the piston. The spacing is a function of the distance through which the rod falls. An orifice is provided near the base of the cylinder wall of the jack, communicating through a non-return valve with a tank. During the accelerated part of the piston fall, the gas that is expelled by the piston as it drops from its upper position, escapes through holes in the hollow rod and the orifice. Towards the end of the fall the free escape of gas is no longer possible, because it can escape only through the calibrated orifice. Thus, the gas under the piston is compressed and absorbs the kinetic energy of the rod. (IIB)

4425 NUCLEAR REACTOR LOADING AND UNLOADING MACHINE. (to Electricite de France). French Patent 1,395,856. Mar. 8, 1965. Filed Mar. 6, 1964.

The loading and unloading machine is adapted to be sealingly connected to standpipes opening in the pressure vessel of a gas-cooled reactor. The machine comprises on the one hand, two subassemblies each bounding a sealed chamber and each provided with a shield forming part of the biological protection against the radiation of the fuel elements contained in the machine. Each shield is formed with a gap while the bottom subassembly is adapted for coupling to the standpipe and the top subassembly is adapted for sealing-tight coupling to the bottom subassembly in a position such that the gaps register with one another. Two radiation-absorbent elements are placed in such a way, that the first is locked to the top subassembly during relative displacement of the two subassemblies in a transverse direction with respect to the gaps and is locked to the bottom subassembly when it is situated level with the gap in the shield in the bottom subassembly. The second radiation-absorbent element is locked to the bottom subassembly during the mentioned displacement and locked to the top subassembly when it is situated level with the gap in the shield thereof. (IIB)

GENERAL

4426 (ANL–7149) GYRO II: A MACRO-DEFINED SYSTEM FOR LIST PROCESSING. Carson, Daniel F.; Robinson, George A. (Argonne National Lab., Ill.). May 1966. Contract W-31-109-eng-38. 38p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

A formal description of the GYRO II language is presented and the implementation for the Control Data 3600 at Argonne National Laboratory is discussed. (B.G.D.)

4427 (ORNL–4005) BIASES OF ESTIMATORS FOR THE NEGATIVE BINOMIAL DISTRIBUTION. Bowman, K. O.; Shenton, L. R. (Oak Ridge National Lab., Tenn.). Nov. 1966. Contract W-7405-eng-26. 126p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The parametric form of the negative binomial distribution considered has mean pk and variance pk(p + 1) and probability generating function $(1 + p - pt)^{-k}$. It is well known that the maximum likelihood estimators $\hat{p}$, $\hat{k}$ of p, k are biased. If the sample size is n the biases may be expanded as series in descending powers of n, the higher order terms being almost impossible to find. Here we give a tabulation of the terms in the series depending on n^{-1} and n^{-2}. The table may also be used for the asymptotic biases of two other well known parametrizations. (auth)

4428 (ORNL–4031) CONTOUR, A FORTRAN SUBROUTINE FOR PRODUCING CONTOUR MAPS. Branstetter, E. E. (Oak Ridge National Lab., Tenn.). Nov. 1966. Contract W-7405-eng-26. 24p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

A FORTRAN-63 program to produce a contour map of a function f(x,y) of two variables is described. It has been written for use with the CDC 1604A computer and the Calcomp 580 incremental plotter system. The function f must be defined and single-valued in a rectangular domain in the x-y plane and f must be known at discrete points equally spaced in each coordinate direction of this domain. The curves f(x,y) = c determined by the intersection of this function f and planes parallel to the x-y plane at specified levels (values of c) are located and represented as sequences of x-y coordinates. A contour map is produced by plotting on the same graph the line segments connecting the coordinates of each sequence and making suitable identifications. (auth)

4429 (UCRL-16806, pp 15-16) LOCALIZATION OF CHLOROPHYLL IN SPINACH CHLOROPLAST LAMELLAE BY FLUORESCENCE AND ELECTRON MICROSCOPY. Lintilhac, P.; Park, Roderic B. (California Univ., Berkeley. Lawrence Radiation Lab.).

Chlorophyll in green plants is generally thought to reside in the internal membranes of lamellae of chloroplasts. These membranes are observable by electron microscopy, and can be roughly grouped on the basis of size and arrangement into grana and stroma lamellae. These lamellae exist as closed, flattened sacs or thylakoids. Although the chlorophyll molecule itself is not demonstrable by electron microscopy, it is readily detected by fluorescence microscopy. A technique is described for the observation of the same specimen by fluorescence and electron microscopy, yields precise information on the distribution of chlorophyll in the membranes through a direct comparison of ultrastructure and fluorescence. (C.H.)

4430 (UCRL-16806, pp 34-8) HEREDITY, ENVIRONMENT, LEARNING, AND THE BRAIN. Bennett, Edward L.; Hebert, Marie; Morimoto, Hiromi; Orme, Ann (California Univ., Berkeley. Lawrence Radiation Lab.).

Experiments on rats raised in isolation (IC) and those raised in a behaviorally enriched environment (ECT rats) showed that anatomical and chemical characteristics of a rat's brain can be changed by the behavioral environment. The ECT rat has a heavier cortex, lower AChE activity/mg, and higher ChE activity/mg. The ECT rat has a higher cortex-to-subcortex weight ratio and a higher cortical-to-sub-cortical ratio of ChE to AChE. The ECT rat also has a thicker cortex, a higher glia-neuron ratio, and perhaps greater dendritic branching than his IC littermate. Similar environmental enrichment enhances learning ability in a Visual Reversal Discrimination Test. The characteristic weight and chemical pattern found when ECT rats are compared with IC rats is also found in comparisons between bright and dumb strains. Taken together, all of these results suggest a chemical and anatomical basis for the learning ability of the rat. (C.H.)

4431 (UCRL-16806, pp 42-3) PRODUCTION OF CYSTEIC ACID, TAURINE, AND CYSTAMINE UNDER PRIMITIVE EARTH CONDITIONS. Choughuley, Ahmed S. U.; Lemmon, Richard M. (California Univ., Berkeley. Lawrence Radiation Lab.).

It is now well established that most of the simple, biologically important monomers (such as amino acids, pentoses, purines, and fatty acids) are formed when various high-energy sources are applied to samples of the primitive Earth's atmosphere. This atmosphere is assumed to consist mainly of CH_4, H_2O, NH_3, N_2, and H_2 (the last decreasing rapidly with increased age of the Earth). Results are reported from a search for the primitive-Earth synthesis of S-containing amino acids using $H_2{}^{35}S$ as one of the reactants, thus greatly increasing the detection sensitivity for an amino acid product. The appearance of cysteic acid, $HO_3SCH_2CH(NH_2)CO_2H$, and the closely related compounds taurine, $HO_3SCH_2CH_2NH_2$, and cystamine, $(SCH_2CH_2NH_2)_2$ was established. Cysteine and cystine probably were formed (there was evidence for them in early chromatograms), but they appeared to be oxidized to cysteic acid during subsequent chromatography. No evidence was found for methionine production. In each of the three experiments reported, 20 ml of 2N NH_4OH, 200 mm of CH_4, and 100 mm of $H_2{}^{35}S$ (containing 5 mcurie) were placed in a Pyrex tube and irradiated, with an electron beam, at a radiation dose of about 10^9 rads in the absence of air. The following ^{35}S-labeled products (yield from $H_2{}^{35}S$ given parenthetically) were positively identified: cysteic acid (0.01%), cystamine (0.003%), and taurine (0.01%). Cysteine, cystine, and methionine were not found. (C.H.)

4432 (UCRL-16806, pp 44-52) MECHANISM AND PROTO-BIOCHEMICAL RELEVANCE OF DICYANAMIDEMEDIATED PEPTIDE SYNTHESIS. Steinman, Gary; Kenyon, Dean H.; Calvin, Melvin (California Univ., Berkeley. Lawrence Radiation Lab.).

The mechanism by which dicyanamide (DCA) promotes the synthesis of diglycine from glycine in aqueous solution was investigated in detail using carbon-14 and tritium-labeled compounds. It was found that protonation of both dicyanamide anion and the glycine carboxylate group are required for dipeptide synthesis. Peptide bond formation is apparently initiated by reaction of the glycine carboxyl group with dicyanamide to form an unstable intermediate which undergoes nucleophilic attack by the amino group of a second glycine molecule, resulting in the production of diglycine and cyanurea. N-cyano-N'-glycyl-urea occurs in the reaction mixture as a prominent side product, suggesting that DCA induces peptide bond formation via an intermediate similar to that postulated in the case of the dialkylcarbodiimides. The possible role of DCA-mediated polypeptide synthesis in prebiological chemical evolution is discussed. (C.H.)